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INDUSTRIES OF AMERICA

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MANUFACTURING

By

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A Volume of
INDUSTRIES OF AMERICA

MALCOLM KEIR—EDITOR



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PREFACE

Full participation in the life of the world today, any real comprehension of our political and social institutions and their practical relationships, call for some organized understanding of economics; and this not merely in generalities, but in its application to the industry and business by means of which all of us live. Certainly for Americans an essential element in personal distinction and leadership is a knowledge of our country's industrial structure, its development and basic trends, its relations to other phases of our national life.

On November 11, 1918, when American citizens deliriously rejoiced at the military ending of the World War, they were unconsciously celebrating the close of an American industrial epoch. For, in broad terms, our industrial history has been marked by three significant phases, the second of which closed with the World War.

During the century after the signing of the Constitution, the executives in American industries were compelled to focus their attention on problems of production because the nation expanded at such a rapid rate that demand constantly outran supply at existing cost levels. In the manufacturing industries this century was outstanding in respect to the shift from handicraft methods to production by means of power-driven machinery.

About 1880, farmers, mine operators, and particularly manufacturers became aware of a fundamental change in conditions. Our free land was fairly well settled, our rate of growth was slowing, our productive capacity had at last overtaken the demands of consumers. To accommodate themselves to this situation our producers paid relatively less attention to problems of production; instead, and for the most part for the first time, they started an intensive study of marketing, salesmanship and advertising. For a generation or more, problems of distribution outranked those of production. But as early as 1910 signs were not lacking that this second phase of industrial evolution was

waning. Then came the World War, a heady stimulant to all our producing industries. The tonic was so excessive that when Armistice Day came it found our productive capacity far in excess of any domestic consumer's demand, or any foreign demand that we then had developed. In addition to excess capacity, our producers soon found themselves confronting unusual conditions as to prices, employment and wages. It became evident that the old order was crumbling and a new one was rising.

The third stage of our national industrial life, into which we passed after the World War, is an age not of production dominantly, nor of distribution dominantly, but one in which attention must be given to production and distribution alike, in which the effort of the nation's business interests is to coordinate broadly the forces and instrumentalities of both production and distribution and thereby secure a steady and continuing progress.

Under realization of this fact the leaders of American business have been setting themselves to a systematic study on the production side of the problem, at once more intensive and more far-reaching than the world has known. The aim is not merely conveniently to adjust current problems in production and sales, but to comprehend the part filled by each industry—viewed in historical perspective and in its relations to others—in our national economic structure. This series of books on INDUSTRIES OF AMERICA, of which the present volume is the first to appear, seeks to record and sum up this comprehensive study which our age is developing.

The series undertakes to give a comprehensive picture, in readable terms, of American industrial development. It includes volumes on individual branches of industry—farming, mining, lumbering, transportation, electrical communication, and finance—each of them prepared by a man connected with the productive enterprises about which he writes, and at the same time able to present his industry in its historical and social background. In addition it will contain books of more general scope. One deals with the geography of American industries. Another synthesizes the data from all industries into general economic laws. A third—the present volume—does for the most important manufactur-

ing industries what is accomplished by the books that deal with single productive pursuits such as mining or transportation.

The volumes, while free from technical terms, are written by men familiar with the technology of the industries covered. In their preparation unusual pains have been taken, alike by the editor and the individual authors, to orient each volume into the series as a whole. The series presents both material and points of view not readily obtainable from other sources. It brings out relationships of facts which ordinarily have not been stressed. It is hoped, therefore, that new light will be thrown on many problems, and the reader enabled to make broad and correct evaluations of forces that are shaping the everyday lives of our population and thereby rapidly moulding the destinies of our nation.

The present volume is a self-contained unit, and may be read as such. In 1920 the author, who is also the editor of the whole series, published through The Ronald Press Company a volume entitled "Manufacturing Industries in America," and some of the material of that earlier issue has been here rewritten. The present work, however, is virtually a new contribution, wider in range and more fundamental in approach. Inasmuch as it is the first of the series to be published, the opportunity has been taken to outline at this time the scope and purpose of the entire group.

MALCOLM KEIR

Hanover, N. H.,
August 20, 1928.

CONTENTS

CHAPTER	PAGE
I AGRICULTURE	3
II LUMBERING AND MINING	28
III POWER	58
IV HOUSEHOLD MANUFACTURES AND CRAFTSMANSHIP	83
V THE DEVELOPMENT OF THE FACTORY SYSTEM	100
VI LOCALIZATION AND DECENTRALIZATION OF INDUSTRY	120
VII THE PEDDLER—HIS SERVICES TO EARLY MANUFACTURERS	149
VIII IRON	162
IX STEEL	186
X THE AUTOMOTIVE INDUSTRY	213
XI MEAT—THE ERA OF LOCAL INDUSTRY	245
XII MEAT—THE ERA OF CENTRALIZED INDUSTRY	262
XIII NORTHERN COTTON MANUFACTURE—ERA OF WATER POWER	288
XIV NORTHERN COTTON MANUFACTURE—ERA OF MECHANICAL POWER	309
XV SOUTHERN COTTON MANUFACTURE	329
XVI WOOL	365
XVII SILK	405
XVIII LEATHER	427
XIX THE SHOE INDUSTRY	445
XX PAPER MANUFACTURE	471
XXI CEMENT, BRICK AND POTTERY	495
XXII GLASS	527
XXIII AMERICAN LABOR	547
XXIV LABOR'S INDUSTRIAL PROBLEMS	570

**MANUFACTURING INDUSTRIES
IN AMERICA**

CHAPTER I

AGRICULTURE

Relation of Agriculture to Manufacturers.—Ever since factories began to take over the production of goods formerly made in the home and to draft as employes former farm hands, a strange misconception has arisen regarding the relation between agriculture and manufactures. It is generally supposed that these two industries are antagonistic. In reality fields and mills are as closely connected as man and wife; each is dependent on the other for the fullest realization of its being. More than mines, more than forests and quarries, more than any other source, the soil supplies raw materials for the manufacturer. Farms furnish more than three-fourths of all the materials upon which factories work. On the other hand, farmers have no other single market for their products so important as the mills that dot our land. Fully a half of all the products a farmer raises for sale are purchased for use in our manufacturing plants, to say nothing of the consumption of farm products by dwellers in factory communities. Hence, an industrial nation is fortunate indeed to have its factories backed by a multitude of farms. Conversely, an agricultural community is blessed by the presence within its confines of manufacturing enterprises. No other great nation is so abundantly endowed with farms producing industrial raw materials and supplies for an industrial population as the United States.

The manufacturers most directly benefited by our extensive farm lands are the textile industries. Except for the finest grades of raw cotton our farms supply all the needs of cotton manufacturers. Nearly all the raw material for artificial silk (rayon) also is furnished by cotton plantations. The wool factories draw about half of their supplies from domestic flocks. No other nation is so amply endowed with textile raw materials.

Next to the textile plants, the greatest beneficiary of our farms is the food manufacturing industry. The great packers and the local butchers secure all the animals they dress from American farms. Likewise, a host of canners scattered over the nation draw all their raw materials from our own land. Measured by value the food manufactures are the greatest American manufacturing industry.

The price of farm products is felt in every other industry, for those that do not use farm stuff as raw material hire labor whose wages are influenced by the cost of food or sell the manufactured article to farmers whose purchasing power is modified by prices of farm commodities. Inasmuch as almost three-quarters of all income from manufacturing goes to labor in wages and since labor spends more than a third of its wages on food, it is easy to appreciate why factory executives are interested in prices for farm goods. On the other hand, the farmer's income is spent in part for factory goods so that the prosperity or depression of agriculture has much to do with the absorbing power of the domestic market, and hence with good or bad business conditions. For example, the value of all the farm crops for the single state of Texas is more than a billion dollars, and in each of a dozen other states the value of farm crops is in the neighborhood of a half-billion dollars. These figures become significant when we realize that 48% of the population of our country is rural. The investment in farm property exceeds the combined total in factories, mines and railroads. It is no mistake to call agriculture, "The Primary Industry."

Sources of American Agricultural System.—The farm systems in America were derived from the manorial organization of Europe and the agricultural methods of the American Indians. The manor was the feudal farm owned by an aristocrat of court or church, but operated by graded classes of bondsmen attached to the soil. The area of the manor comprised a central village around which spread three fields, one sowed to spring crops, one to winter crops, and one allowed to be fallow. The designation of these fields was rotated each year in order that a particular plot might recover fertility by fallowing each third year.

Within each field the serfs were allotted non-contiguous strips. For the enjoyment of the products of these strips, the serfs paid the lord a part of the product, as well as a multitude of subsidiary taxes paid in kind, and, in addition, rendered him services. In the latter part of the feudal period these onerous obligations were commuted into money rents. The meadow land of the manor was used freely by all the serfs for pasturage and the manorial woodland was at their disposal for gathering firewood.

Notwithstanding that the manor was in process of disruption in Europe at the time the earliest American settlements were made, its influence upon the colonists was distinct. In New England the characteristic town organization with surrounding fields allotted yearly in strips, the cooperative shepherding and herding, the fallow rotation, all were reminiscent of the manor. In the South, Lord Baltimore and Lord Fairfax, among others, not only planned manorial estates but adopted at first manorial terms and the manorial practice of quit-rent tenure; for that matter quit-rents although sometimes nominal—a red rose paid on May Day—were common in all the colonies except those in New England. The New Netherland patroonships were easily recognizable relatives of the Dutch manor.

Indeed, a quasi-manorial agriculture was well-adapted to the pioneer conditions of America. Close settlement afforded protection from wild animals, Indians and hostile French. Land was abundant and cheap, so the manorial system of rejuvenation of the soil through leaving the land fallow was sound economics. Shortage of labor, moreover, led to the use of cooperative practices—another feature of the manor. In Pennsylvania where at the outset separate individual holdings were tried, eventually the population was clustered for the very reasons cited. The outstanding features of the first settlements, therefore, were derived both from European customs and produced by the environment in America. Those manorial characteristics that fitted the environment survived—such as fallowing—while inconsistent manorial customs like the payment of quit-rents lapsed. Along with manorial methods we transplanted manorial crops, grains of course being predominant.

Debts to Indians.—Our forefathers owed a much greater debt to the Indians than to the European manor. Indian crops not only sustained famishing first settlers but, once adopted by the colonists, led them to ease and sometimes luxury. Indeed it is the plants we acquired from the first owners of this continent that now constitute the principal sources of American agricultural wealth. Among them are corn (maize), tobacco, cotton, potatoes, various beans, squash, pumpkins, tomatoes, berries and grapes. Fully a third of our modern farm produce is of American Indian origin.

After telling our forefathers what to grow the Indians showed them how to plant, cultivate and harvest. Except for modern machinery there is surprisingly scant difference in our farming methods from those conducted for ages by the Indians. The first American agricultural teachers were the Indians, Squanto, advisor to the Pilgrims; Tassore, Kemps, and the maiden Pocahontas, instructors to the Virginians. Moreover, fields cleared for savage agriculture saved a generation of labor for the pioneer set down in a forest.

All the original settlements experimented with European and Indian crops, livestock, and farm by-industries until each learned what combination produced largest returns by conforming to environment and markets. Differences consequently mark the stories of each of the sections of colonial America.

Colonial New England.—The 18th century New England farm ranged in size from 50 to 100 acres. An ordinary 100 acre homestead had from 4 to 6 acres in crops and from 8 to 10 acres in upland grass, the rest being in woods or waste. Such a farm held in fee simple after 1624 was always close to a village where there was a church, a saw mill and a grist mill, and perhaps the houses and small farms of a few artisans. If the village was located on navigable waters there was often a store where European and West Indian goods were exchanged for farm produce.

The cleared acreage was planted in corn, squash, beans, pumpkins and small grains. Some wheat was always to be seen in New England, but since it was subject to rust after 1665, wheat

was only for a brief period an important crop. Bounties on hemp and silk encouraged their production at times but never successfully. Hemp was most profitably raised by a few Scotch-Irish immigrants in New Hampshire. Nevertheless, hemp was frequently a garden plant where it was not a field crop.

The grass land at first was left in rough, coarse, native grass. In swampy places and salt marshes swamp grass was obtained. English clovers, however, were introduced and in the middle of the century timothy was common. The latter was a European-type plant that came up spontaneously in New England wastes and was called cat's tail grass. Prior to 1720 this grass was used for hay by a man named Herd living near Portsmouth, New Hampshire, and proving valuable, its use spread over New England where it was called "herd grass." About 1740 Timothy Hanson, who probably lived near Portsmouth, took herd grass to New York, Maryland, Virginia and North Carolina where it became popular and was named "timothy" after its introducer. It became the dominant hay plant in the United States.

The grass and hay lands supported the livestock of the New England farm. Upon each farm there were 1 or 2 horses, 1 or 2 yoke of oxen, 5 or more dairy cows, 10 to 20 sheep, and from 5 to 15 pigs. The horses were for riding, because the work animal was the ox. The ox was less nervous than the horse, a valuable trait in rough plowing and cultivating, and, moreover, had a lower first cost, cheaper upkeep, and could be converted into beef when his work days were done.

While at first all the livestock of a community was herded or shepherded on common, natural meadows, by old men or boys appointed by the town, with each animal branded or ear-marked to denote ownership, as time passed each farmer allowed his stock to run at large through his own waste and wood lands. Winter feeding was generally scanty and often no shelter was provided. Lack of labor explains the inhumanity, and the absence of a quality market determined the indifference to breeding and condition. As a result, livestock were of no definite heritage, ill-formed and unproductive.

The preponderance of woodland on the farms provided fuel, lumber, and tool parts. Lumbering was a winter bye-time job.

Staves and boards, potash and pearlash, were saleable products from the wood lots. When the woodlands were cleared the area for crops or meadows should have been increased. However, as cropped land declined in fertility it reverted to pasture or brush while the newer clearings were planted. This apparently careless utilization of land was caused by the fact that land was cheap and abundant, while labor was dear and scarce.

Throughout the 17th century and part of the 18th, the New England farm was practically self-sustaining. For the house the only purchased articles were window glass, bar iron (for hardware) and rod iron (for nails). Of comestibles only salt, molasses and rum were bought. Broadcloth for the master's suit, silk for the mistress' dress and shoe buckles for both were the only parts of apparel the farm did not produce. Labor was furnished by members of the family, although some neighborly cooperation occurred in barn raisings and "bees."

During the 18th century this self sufficiency began to weaken. The villages and particularly the ports created markets for surplus farm stuff not alone for consumption but for export. Blacksmiths, tanners, cobblers, fullers, cabinet makers, and other village artisans supplanted or supplemented home manufactures, while the village store displayed dress goods from Europe, tea, coffee and chocolate from the tropics, and sugar, molasses and rum from the West Indies. The farmer, in consequence, paid more attention to the saleable products, particularly from animals.

Connecticut River Valley and Rhode Island.—To the general history of New England's colonial agriculture two areas, the Connecticut River Valley and Rhode Island, constituted exceptions. Attracted by Indian reports of great meadows, a trading expedition went to the Connecticut River Valley in 1633. Migrations to the valley started two years later. The pioneer farms in this valley generally were larger (up to 300 acres) than those eastward and from the start devoted considerable attention to stock raising. Toward the end of the 18th century the valley began to raise special crops such as hops, broomcorn, teasles (for the textile industry) and tobacco, the latter being marketed by the ubiquitous Yankee peddler.

The Rhode Island colony was notable for its large farms, some measured in thousands of acres. In times past extensive clearings for a depth of 8 to 10 miles had been made by the Narragansett Indians, the most advanced savages along the Atlantic seaboard. Upon these Indian clearings the Rhode Islanders at once began extensive animal husbandry. The ease in protecting islands and peninsulas from ravages of wolves and Indians, the mild winter, the great evenness of summer rainfall, with consequent green meadows, all conduced to profitable animal husbandry. The settlers were anti-Puritan—gambling, horse-racing, fox-hunting gentry—who, boycotted by the rest of New England, developed their own commerce and markets. Theirs was a slave-operated, large-scale, animal agriculture conducted on plantations. They developed a famous breed of riding horses—the Narragansett pacers—the various breeds of Rhode Island poultry, and a famous greening apple. Their sheep, while not so noted, were numerous and furnished in their wool a valuable commercial product. Likewise, their dairy products were favorably known. Commercial agriculture, therefore, had an early start in Rhode Island.

The Middle Colonies.—The agriculture of the Middle Colonies, while it resembled that of New England, differed in many respects. The Dutch of New York, Swedes of the Delaware River, and Germans and Quakers of Pennsylvania, all were better, more careful farmers than the Pilgrims or Puritans. Indeed, Pennsylvania became the wealthiest, most flourishing agricultural colony of all the original thirteen. It was the colony in which immigrants most easily could acquire citizenship, and land grants were liberal and fair. It attracted an unusual number of intelligent farmers who fled religious or political persecution in Europe. It had large areas of fertile soil, among them Lancaster County, to this day one of the most productive farm areas in the United States. Being later in inception, Pennsylvania escaped the worst rigors of pioneers, and drew upon the established colonies for supplies and equipment. It had no militia and suffered but slightly from the French and Indian Wars. Its labor problem was less acute because it made considerable use of indentured

servants who, in many cases being aliens, deliberately chose a period of indenture to learn the English language and American farm methods. Finally, farming in Pennsylvania was influenced by the fact that Philadelphia grew to be the greatest colonial city, the center of wealth, learning and science, as well as a leading commercial port.

In all of the Middle Colonies, wheat was a more important crop than in New England, and in Pennsylvania the wheat acreage exceeded that for corn, the only colony where that was the case. The farms of the Middle Colonies had a greater proportion of their area in tilled lands and their agriculture was better balanced than in New England. The back country of all the Middle Colonies paid considerable attention to animal industries; in particular, Long Island was to New York what Rhode Island was to New England.

Colonial Agriculture of the South.—For twelve years after Jamestown was founded, the settlers, in conformity with the commercial purposes of the company of merchants who financed the project, were farmers only by the compulsion to escape starvation. They sought quicker sources of wealth than soil tillage. Ten years after the first vessel reached the James River, the colony harvested its first large crop of tobacco, although John Rolfe had planted Indian tobacco as early as 1612. The profitable sale in England of the 1617 crop toppled the remnants of Virginia communism and substituted in 1619 individual land grants. Comely maidens to the number of 90 for a purchase price of 120 pounds of tobacco apiece were sent to the newly created landed proprietors to establish real homes. At the same time all legal restrictions were removed on the planting of tobacco and a great farm boom started. Inevitably tobacco prices fell. Thereupon quality rather than quantity became the chief market factor and was reflected in crop management. Under rigid state regulation only high-grade leaf was exported.

Meanwhile Maryland was settled and soon turned to specialization in tobacco. The competition of the two colonies caused tobacco prices to waver. Agreements to limit production were tried but violated by both parties. Each, to save itself, was

forced to emphasize quality. In both colonies the principal cash crop was tobacco, and within the producing colonies the leaf or warehouse receipts for it served the function of currency.

At no time either in Virginia or Maryland was tobacco the sole crop nor even the principal one in acreage. Corn held that rôle. Likewise much land was planted in other supply crops such as squash, pumpkins and sweet potatoes. At times an alternative cash crop was sought and encouraged by bounties. Flax, hemp and silk production were promoted in order to afford escape from dependence upon tobacco, but none of these, despite liberal governmental rewards, ever gave serious competition to tobacco.

Plantation System.—The characteristic Tidewater Farm was a large plantation. It never was cleared entirely at one time; since tobacco was exhausting to soil, new clearings constantly were made. The old tobacco land was put in supply crops for a period and then allowed to revert to brush. Only a large acreage could stand such ravages; even so, new plantations eventually were necessary.

Indentured white servants filled the need for labor in the earliest history of Virginia and Maryland. Negro slaves, however, soon constituted the labor force, being cheaper to maintain, certain to be retained, and more productive for the capital invested than was the case with indentured whites. As the work was arduous and continuous, demanding skilled supervision rather than expert workmanship, the crop system fitted slavery.

Most of the tobacco was sold in Europe, being transported in British ships. It was said that one Virginia tobacco slave gave employment to four Britishers as sailors, merchants or craftsmen. It was the interruption to the tobacco trade during the American Revolution that turned Glasgow merchants to cotton manufactures, obtaining the raw cotton from the British West Indies. Tobacco, too, entered into intercolonial trade. Ships from New England and New York exchanged provisions for tobacco. These same ships, together with a few from Virginia and Maryland, carried tobacco to the West Indies in trade for sugar, molasses and rum.

Upon the proceeds from tobacco, Tidewater Virginia and

Maryland founded a wealthy, luxurious, sporting society, a cultured, travelled and educated aristocracy.

South Carolina.—Much of the story of Virginia, including the early hardships and eventual wealth, was repeated in South Carolina. In 1696, a chance visit to Charleston by a Dutch boat brought to Carolina a half bushel of Madagascar rice. From this handful of seed, much superior to the rice which the Carolinians previously had planted and failed to sell, arose a great rice plantation industry.

The uplands of the rice plantations were devoted to indigo, a four-foot shrub whose bluish green leaves for centuries were the main reliance of dyers for a blue color. First demonstrated by a woman as a profitable Carolina farm product, indigo harvesting was greatly encouraged by bounties offered by the British government and it soon became a staple, second only to rice.

These two crops admirably supplemented each other in the type of soil demanded, seasonal requirements for labor and the time of harvest. With two cash crops, one of which (indigo) was always short in the British market, the planters of South Carolina were in an economic position superior to the tobacco planters of Virginia or Maryland.

North Carolina.—The sister colony, North Carolina, was not so fortunate, for three-fourths of the Tidewater sections were separated from direct access to the ocean by shallow sounds and outlying sand bars. Cape Hatteras was notorious among sailors as a danger spot. The inland Piedmont area was held in small acreages by Scotch and Scotch-Irish, as well as migrants from Pennsylvania.

Southern Cattle Ranges.—From Pennsylvania and Maryland to the Carolinas, the Piedmont in the latter part of the 18th century was one vast cattle range. Horses, beef animals and hogs ran wild throughout this back country. Germans, Quakers and Scotch-Irish set up ranches in the region and carried on an animal industry similar in every detail to that afterwards familiar in the "great open spaces" of the West. After round-ups, the animals were driven either to the Tidewater Plantations for sale

or slaughter, or were sent to Baltimore and even Philadelphia for stall feeding, local consumption and export. Salted meats and hides also came down to the coast from the interior ranches. The restless, bellicose, armed ranchmen afforded an excellent bulwark to the Tidewater against depredations by Indians or French.

Between the coastal plantations and the frontier ranches in Pennsylvania, Maryland and Virginia were the inland farms that constituted the colonial "wheat belt."

Westward Migrations.—Migration always has been characteristic of Americans. As early as 1640 New Englanders attempted to settle along the Delaware River and soon afterwards they appeared at the present site of Annapolis, Maryland. Prior to 1661, they tried to colonize Cape Fear, North Carolina. Their most successful early migrations were those into Rhode Island, the Connecticut River Valley and Hudson Valley. They also went into New Jersey.

As long as the French menaced the British colonies it was politic to conciliate the Iroquois Indians in central New York. After 1763, the whites began to push the Indians out of the Mohawk Valley and to penetrate the fertile Genesee Tract, although the latter was not officially open to settlers until after the Revolution.

Trickling from Pennsylvania and from across the Piedmont, settlers appeared in the Shenandoah and Cumberland Valleys. In 1763 a British proclamation prohibited permanent homesteads west of the crest of the Alleghanies because settlements would interfere with the fur trade, impose an onerous burden on Great Britain for protection and incite political or military aggressions by the French who claimed the region. This manifesto was ignored, however, so far as it affected actual settlement, although it made impossible territorial organization west of mountains.

After the Revolution, backwoodsmen led the way for farmers into Kentucky, Tennessee and the Northwest Territory. Eastern Maine, northern New Hampshire, Vermont and New York, and western Pennsylvania shared with the new West in this post-Revolutionary incursion. By 1810 the Ohio River and Tennessee River Valleys had lured many farmers from Kentucky, Virginia

and North Carolina, while the advance guard was penetrating the Mississippi Valley north of its junction with the Ohio. At the same time the lands near the mouth of the Mississippi were filling with people.

With the way pointed out, succeeding decades saw pioneers advancing along all the mid-western river valleys, at first from the South but after the building of the Erie Canal, they went also by way of the Mohawk Valley and Great Lakes. By 1840 there was a thin layer of people nearly everywhere between the Atlantic and the Mississippi. However, only the southern portions of Michigan and Wisconsin were settled at this time.

Then came the long overland journeys to Oregon and, after 1849, to California. The railroads after the Civil War made possible expansion into the level lands beyond the Mississippi and onward to the Great Plains and over the Rocky Mountains, the Cascades and Sierras. Never in so short a time has such a vast area been peopled.

Western Pioneer Agriculture.—To the time of the Civil War the agriculture that accompanied westward migration fell into three types, representing overlapping waves in the settlement.

First, those who constituted the advance guard practiced a farming almost identical with that conducted by the earliest pioneers in New England and the Middle Colonies. Forest clearings, the axe and gun, sustenance crops and animals characterized it. Its independence was coupled with agricultural slovenliness and oftentimes personal deterioration, for isolation is deadly to human kind. As in New England and the Middle Colonies, labor was furnished by the family supplemented at rare intervals by neighborhood cooperative efforts. The second wave of migration rolled into the primary clearings, awakening some of the pioneers, extending the holdings, improving the farm methods and introducing some measure of interdependence. The true pioneer was washed on in advance of this second wave to begin again in a less crowded region. The third, and tidal wave, brought villages, towns and cities with orderly government. Farmers found outlets for farm stuff first by natural or artificial waterways and then by railroads. The consequent reorganization of land and

crop management caused cash crops to supplement or exceed supply crops.

These successive inundations of people flowed westward by way of stream valleys and forests. Prairies, small or large, were avoided. Trees, especially hardwoods, denoted good soil to folks with two centuries of forest agriculture bred into them. Forests, too, provided building material, fuel, game, and water, all of which were thought to be lacking on the prairies. It was not until the day of the railroad and steel plows that many men ventured far out into the open spaces.

Corn was the King of frontier crops.

From Plymouth to Astoria, from Jamestown to St. Joseph, corn colonized America. It yielded a large crop—40 to 60 bushels per acre in Ohio, 80 bushels in Illinois—in new land cluttered with stumps. It was easily handled, its enemies readily exterminated, and its diseases fewer than for any other cereal. As for storage, it could be stacked all winter in the field protected by its own close-fitting shuck. Corn was usable for fodder, sugar, illuminating oil and fuel. It fed and warmed man and beast.

The most economic frontier animal was the hog. The maintenance cost of hogs was low, since they were fed on refuse from the kitchen and barn, or orchard windfalls. Oftentimes they ran at large, finding their own food. Although frightful toll was levied on other farm livestock by wolves, snakes and native wild things, these savage marauders held little terror for the bellicose hog. Even man shrank from battle with an enraged boar. Hogs, too, were prolific, a valuable trait where man faced starvation. For preserved meat, hogs were the source of ham, bacon, sausages, and lard, while fresh pork was available immediately after slaughter. Corn and hogs not only were the mainstays of the frontier but always have been the fountain heads of American agricultural wealth.

The frontier work animal was the ox. Not until the middle of the 19th century, when horse-tools and horse-machinery became common, was the ox supplanted. Dairy cows, sheep, poultry and bees were included in the economy of many frontier farms.

As the frontier rolled forward the country eastward turned to general farming. At the same time various specialties were

tested in each region until experiment proved what products best suited environment and market.

Changing East.—Meanwhile, the older farm areas nearest the Atlantic were subjected to several different pressures, which changed the character of eastern agriculture. There was a loss of man power both to the frontier and in the east itself to expanding industrial cities. The factory towns, however, provided nearby domestic markets for eastern farm products, and furnished farms with many articles formerly manufactured in the home-stead. Competition with frontier farms caused a decline in eastern grain grown for market and livestock produced for slaughter. On the contrary, bulky perishable products, such as vegetables and fruits, not transportable from the west, increased on eastern farms. Dairy cows or poultry replaced beef and hogs. Sheep reared for wool were supplanted by the production of lambs for meat. Another important innovation was the cropping of hay for city horses.

The South.—Following the industrial revolution and the invention of the cotton gin, the South's great cash crop was cotton. Specialization in cotton culture was far more intense than the colonial concentration upon tobacco, rice and indigo. With the rise of cotton it is true that the South fell short of self-sufficiency in other crops, but the dearth of supply crops never was as great as has been assumed by many persons who have written about the South. Yet the difference between consumption and supply was great enough to constitute an excellent market for some of the northern farm products, both those of the changing east and of the frontier.

Regional Specialization Since the Civil War.—Regional specialization in our national agriculture has been accelerated since the Civil War. Factors in this movement have been the prodigious improvement in transportation by water, rail and highway, the advance of agricultural machinery and equipment, and the teaching and practice of scientific agriculture and advanced animal breeding, aided by federal, state, county and municipal agencies. Industrialization and urbanization, also, have

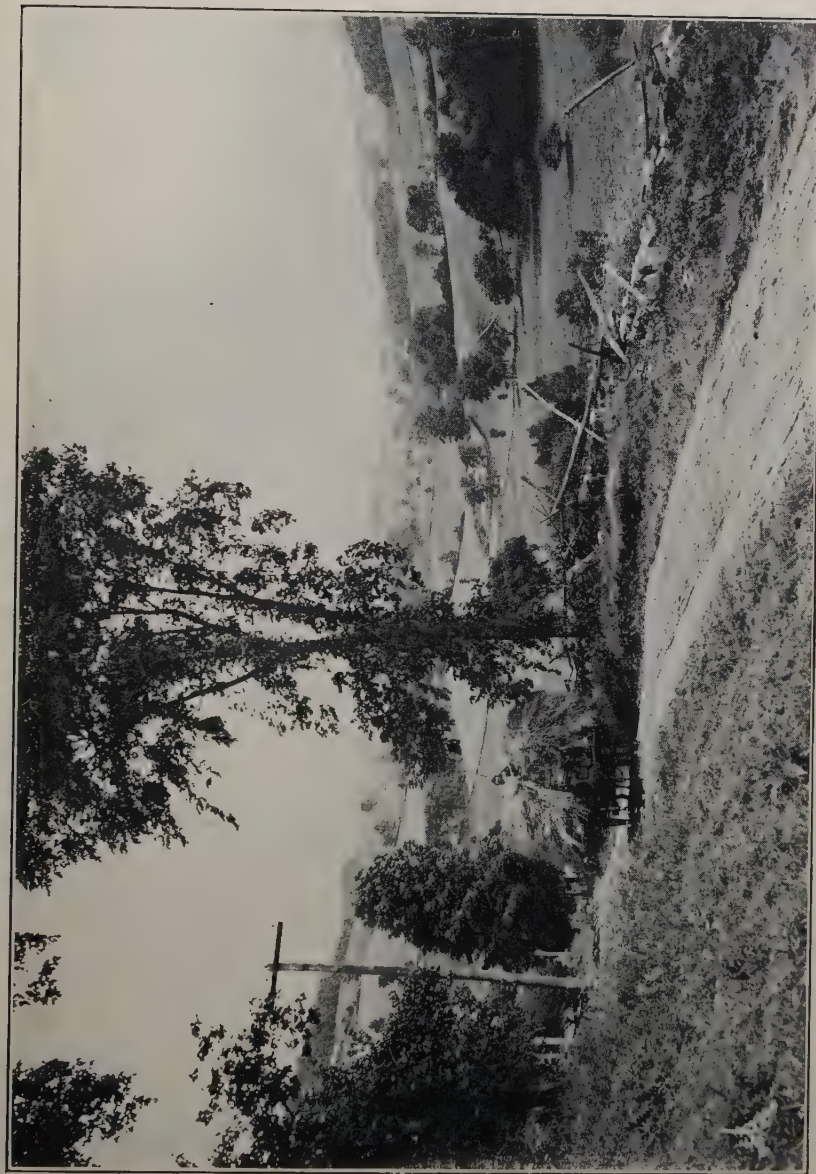


PLATE I. Farm Land in Hoosac Valley of Massachusetts and New York.

(Courtesy Boston and Maine Railroad.)



PLATE 2. The "Combine." A machine that performs all the operations of harvesting grain.
(By Ewing Galloway, N. Y.)

been important influences shaping our agriculture. Finally, powerful pressure has been applied by the improvement in world communication and commerce and the settling of new lands overseas, particularly in South America and the British dominions.

Specialization is both possible and profitable because some places, by reason of soil, climate, market or price of land, are better suited to certain products than other regions. A specialist gains thorough knowledge of his one cash crop and he may also learn to sell it to best advantage. Since men differ, specialization permits adaptation of product to personal satisfaction in work.

New England farmers devoted their resources to dairy products and for a saleable crop depended on hay and forage. This was true also of most of New York and much of Michigan and Wisconsin. From Cape Cod and Long Island southward to Florida, as much of the sandy soils of the Atlantic Coastal Plain was devoted to truck and fruit crops as the markets would absorb. The northern Piedmont farmers in Maryland, Virginia and part of North Carolina raised tobacco, while the southern Piedmontese planted cotton. This crop extended westward across the southern Mississippi Valley to the arid cattle country of western Texas and Oklahoma. Along the highland bordering the Ohio River much wheat was grown, sharing land with corn, but in most of Ohio, Indiana, Illinois and Iowa, corn was the supreme crop. Based on corn, this region also became the greatest producer of hogs, horses and livestock fattened for market. Westward in Kansas and Nebraska and northward in Minnesota and the Dakotas, the Corn Belt shaded into the Wheat Belt. Beyond the Wheat Belt and extending north and south from Canada to Mexico were the great cattle and sheep ranges. The territory between the Rockies and Cascades or Sierras was devoted to wheat, cattle and sheep, some on semi-arid ranches, some connected with irrigation projects. The Pacific Coast from north to south produced grains, livestock and fruits.

Within each of the broad regions outlined there were areas with well-defined but limited and local specializations of different characters. For illustration mention may be made of the potato region of the Aroostook Valley in Maine, the grape vineyards of

northern New York and Pennsylvania, the apple orchards of the Ozarks, and the lettuce farms of the Rockies.

Relationship Regional Specialization to Commerce.—Everyone recognizes that one of the chief causes of commerce is the regional difference in resources. Both domestic and foreign commerce arise from exchanges of the goods of one region for those of another. Since partial regional specialization began in the colonial period, the domestic commerce before the Revolution was based upon interchanges of specialties.

New England sold livestock, meats and dairy products to the Middle Colonies and the South, receiving in return from them grain, flour, tobacco, indigo and rice. All the colonies swapped drinks. New England cider and rum were exchanged for the beer and brandy of the Middle Colonies and the imported liquors found in the South.

With respect to foreign commerce neither New England nor the Middle Colonies had agricultural resources for direct trade with Europe, but both these regions did business with the West Indies whose plantations were devoted to sugar. New England farmers shipped to the West Indies horses and the oats to feed them, salt-beef and pork, cheese, butter, apples and cider. From the woodlots were sent potash, pearlash, soap ashes, staves, shingles, hoops, lumber and barrels. The Middle Colonies sold grain, flour, live cattle, meat and beer to the West Indies. Sugar, molasses, rum and slaves were returned to New England and the Middle Colonies.

The South, of course, sent shiploads of tobacco, rice and indigo directly to Britain to pay for manufactured articles.

In all the colonies there were interchanges between the back country and the coast towns. The hinterland farmers sent to the coast livestock, salt meat, dairy products, poultry and eggs, flax-seed and linseed oil and forest commodities. Much of this stuff, of course, passed on into foreign commerce.

The intersectional commerce was almost entirely water borne but the local trade in winter was carried on sleds and puns. In Pennsylvania conestoga wagons hauled farm stuffs to Philadelphia from as far inland as 60 miles.

Post Revolutionary Agricultural Commerce.—After independence and federalization the domestic commerce in agricultural commodities due to regional specialization became increasingly important. In general this commerce flowed from west to east and from north to south. The West—wherever it was located—sent grain, livestock, beef and pork both to the East and to the South, taking pay in money, manufactures and imported goods. The East supplied its local city markets with hay, dairy products, poultry, eggs, fruits and vegetables, firewood and charcoal. The South sold cotton and tobacco to the North. The foreign commerce dealt in western grain, flour, livestock and meats and southern cotton. Farms continued as the mainstay of foreign commerce.

Since the Civil War.—The regional specialization that began after the Revolution was intensified with the growth and spreading of population after the Civil War, together with the vast improvement in railway facilities. Interregional domestic trade in farm goods has increased amazingly while the percentage of total crops entering foreign trade has declined, and the primary place of agriculture in foreign trade has suffered a loss in favor of manufactured articles. That is, we consumed at home more of what we produced and in place of selling abroad our raw materials, traded the handiwork of our craftsmen. The change has been going on for a long time but has been accelerating most rapidly since 1892.

Of all the forces that have produced this decline of foreign trade in agricultural commodities the most influential has been the rise of domestic manufactures. Our own mills have taken an ever greater proportion of our raw materials. The factory populations have mounted faster than the rural so that our farmers have had a constantly more voracious market at home. Moreover, the industrial area has overflowed its former limited confines in the northeast and has spread across the Middle West and down through the South so that the factories and industrial communities have been edging closer to the agricultural sources of raw materials and food. These changes mean that America

is outgrowing its youth and is becoming an economically balanced nation.

Farm Tools and Machinery.—In no other respect has the American farmer been so distinct from his fellows elsewhere in the world as in his passion for labor saving tools and machinery.

The original settlers who farmed the lands close to the Atlantic had for tools a large and a small hoe, spades, shovels, picks or mattocks, sickles and scythes. As soon as oxen were imported, plows followed. These were so clumsy and heavy that sometimes 6 oxen were required to pull them and less than two acres could be plowed by a team in a day. Such plows were almost entirely wooden except for an iron point and iron plates, and the heavy beam was often supported on wheels. With the introduction of the plow, there came also a crude A-shaped harrow. Wheat and small grains were cut with a sickle, threshed with flails or by trampling with livestock and winnowed by the wind or sieves—tools and methods that had the sanction of at least 30 centuries of use.

In the 18th century the most improved tool was the cradle with which a skilled man could cut from 2 to 2½ acres of grain per day, a four-fold increase over the plain scythe. Other hand tools, such as hoes, were made lighter, and better designed, and fitted with blades or tines of cast steel. Men were experimenting with farm machinery in this century but none of their efforts came to success.

At the opening of the 19th century attention was focused on the plow, first to improve its design or form and, secondly, to substitute iron (later steel) for wood in the moldboard, share, and landside. Charles Newbold of Burlington, New Jersey, patented in 1797 the first iron plow cast in a single piece. Thomas Jefferson by mathematical formula designed in 1799 an improved moldboard while Jethro Wood of Scipio, New York, in 1819 patented a cast iron plow built in separate pieces, to which for the first time were applied the principles of standardization and interchangeability. In the first third of the century no less than 124 patents were granted to Americans for improvements in plows. The best foreign plows also were imported. The result

was a marked saving in the labor, both of men and of animals required for plowing, and an adaptation of plows to special soil conditions. Harrows as well as plows were bettered and after 1820 animal draft cultivators replaced hand hoes for inter-row weeding or loosening of soil. Horse rakes appeared as early as 1812 and were as steadily improved as they were widely popular.

The New Epoch: Machinery.—Although the invention of horse power mowing and reaping machines began with the 19th century, it was not until 1833-34 that practical machines, the work of Obed Hussey and Cyrus McCormick, inaugurated a new epoch in farming.

The epoch since 1830 has been marked by the astonishing increase in power machinery used on the farm. In 1830 patents were issued for 34 agricultural machines; in 1831 the number was 38 and in 1861 it mounted to 350. In 1863 no less than 503 farm machinery patents were issued, for machines had to replace war-drafted men. For a quarter of a century afterward about 100 patents a year were taken out on farm implements and machines. The most spectacular use of machinery occurred in the grain areas. After 1855 reapers were sold as fast as they could be manufactured. By permitting the harvest of larger areas the reaper induced the invention of more rapid threshing and cleaning machines. When these were obtained machine seeders, cultivators and finally gang plows became necessary. Recently a machine called a "combine," because it does the work both of a reaper and thresher, appeared. In 1927 Kansas alone had 10,000 combines which prepared for market in 90 days a crop of 143 million bushels of wheat—enough to fill 60,000 freight cars. The combine does the work of 55 cradlers, binders and shockers, 100 flailers and sackers and about 20 handlers and stackers. That is, one machine with 2 operatives supplanted 175 men—and reaped and threshed 50 acres per day.

One after the other every common farm task has undergone analysis, and mechanical equivalents for hand labor have been invented. This is true of planting, cultivation, harvesting and preparation of crops for use or for sale. Only the picking of cotton and tobacco has defied our mechanicians.

The compelling motive for mechanicalization of agriculture was the paucity of labor in relation to the broad acreages of available land. In the case of wheat the demand for labor was highly seasonal, which provided a further motive for employing machinery. Specialization in a cash crop was both a cause and a result of the use of machinery. Before farm machinery was commonplace, it took all the labor of one family to feed itself; with the assistance of machinery by 1880 one farm family helped to feed part of another family and in 1927 every farm family was supplying the food for two other families. Since this figure does not measure the full potentiality of machine farming it follows that there are still too many people engaged in farming.

Power for Machinery.—When attention first was turned to agricultural machinery the end of the ox as a draft animal was decided. The new technology required more speed and less brute strength; it could be used more effectively with the horse rather than with the ox. Moreover, better roads to nearer markets reached by lighter, easier-running vehicles, favored the horse over the ox. But the triumph of the horse was short.

Even at his apex of popularity, steam farm machinery contested the supremacy of the horse, while the invention of the gas engine challenged the horse to a duel which can have but one end. Already the ten-year period from 1916 to 1926 has witnessed a decline of 5 million in the horse population. A stock census in New York in 1926 showed a decline of 17,000 horses on farms within *one year*. A federal count for the nation for the same period showed a nation-wide decline of horses on farms of 3.5%. In 1925, about 40% of all automobiles were registered from rural communities. There were then about 4 million passenger cars and half a million trucks on farms. The number of tractors, stationary gas engines and electrical power outfits on farms is unknown but casual observation makes these forms of farm power impressive.

Changes are occurring in farm management and in the prices and production of crops. We may well inquire if the sad plight of farmers since the World War has not been due in part to the increased productiveness per farm inhabitant brought about by

farm machinery. The pace of production may have outrun economic adjustment to the increased supplies of farm goods.

Education of Farmers.—The farming of colonial days was operated necessarily by "rule of thumb." However, the agricultural awakening in Europe toward the close of the 18th century was reflected across the ocean in the formation of American agricultural societies. The first of these, "The Philadelphia Society for Promoting Agriculture" organized in 1785, was the pattern for others in Charleston, South Carolina, Hallowell, Maine, New York City, Boston and New Haven. These organizations were all aristocratic in their membership, and their deliberations, publications and prizes, had little influence among "dirt farmers."

Elkanah Watson, a retired merchant living near Pittsfield, exhibited in 1807 two prize merino sheep in the public square, thus inaugurating in America the animal "show." This differed from the ancient "fair" where for ages farmers had collected for *sales* and *purchases* in that the purpose of the show was to *improve farming* by arousing rivalry among "dirt farmers." Shows of the Berkshire type became extraordinarily popular and were supported for a time by state funds. With the repeal of state aid after 1822, together with the onset of a period of rising prices for farm products, the ordinary farmers lost interest in shows. The apathy of dirt farmers may have been caused by the fact that gentlemen farmers regularly captured the show prizes. At any rate the shows declined in number and popularity until about 1850, when they were revived. Ever since that date they have been important incentives to improve farm practices in regard to crops, animals and equipment.

An agricultural press began with the publication in Baltimore in 1819 of the first farm paper, *The American Farmer*. Five other farm journals appeared soon afterwards and by 1840 there were some 30 agricultural periodicals, many of which were local in their interest and ephemeral in their existence. These early journals, when they were not political, contented themselves with reprinting European reports of advances there in agricultural art, much of which was inapplicable to America. Although the number of farm journals constantly increased and some farm books

appeared, it was not until after the Civil War that these were truly American in their contents and favorably affected American farm practices. Since the Civil War, they have been powerful both as political organs and as educational influences.

The first real agricultural college was instituted in Michigan in May, 1857, although credit is generally extended to a short-lived Lyceum founded and taught by Robert Hallowell Gardiner in 1823 at Gardiner, Maine. After Michigan showed the way Pennsylvania in 1859 followed the example. The Land Grant Act fathered by Justin Smith Morrill of Vermont and passed by Congress in 1862 provided the necessary impetus toward the foundation of agricultural colleges (and later, agricultural high schools) throughout the nation.

Among the most important features of these agricultural colleges was their experimental work carried on both at the college and on cooperating farms. By actual demonstration as well as by publications, speeches, exhibits, and special short-term courses, education for improved agriculture has been promoted. It is interesting to note, however, that the first American experimental garden was established on the Ashley River in 1669 by the Lords Proprietors of South Carolina, and that soon afterwards another was set out at Ebenezer, Georgia, by the Saltzburger Community. Both, it is true, were premature, ineffective, and quickly abandoned.

The national government began in 1839 to interest itself in farmers and farming when an appropriation of \$1,000 was granted to the Patent Office for "collection of agricultural statistics, investigations for promoting agriculture and rural economy, and the procurement of cuttings and seeds for gratuitous distribution among farmers." The appropriation was increased each year and by 1856 reached \$100,000. In 1862 the Department of Agriculture was created and began its multifarious duties which have been of incalculable benefit to American farmers.

Three-fourths of the American counties have agents who visit in person the individual farms and render technical assistance to owners. Banks and railroads sometimes augment county funds to further this work. Moreover, many farmers belong to asso-

ciations of their own that furnish advice or information about various phases of farm activity.

The Federal Land Policy.—The federal government has encouraged small holdings, either by charging a small price per acre or by actually giving away public land. In 1785 the charge was one dollar an acre; in 1800 for the Northwest Territory the United States charged \$2 an acre, but by 1820 the price was reduced to \$1.20 an acre. In 1840 preemption rights were granted small holders; a man who lived upon the ground was given prior claim to it, and the payment of \$1.25 an acre for it was made easy by liberal terms. In 1862 the Homestead Act provided that any person could secure 160 acres simply by living upon and developing the land for five years.

We could well afford to be generous with land because it was the common opinion—voiced even by a cabinet officer shortly after the Civil War—that it would take five hundred years to settle all of our public domain. But our liberality resulted in an overwhelming immigration, so that our supply of public lands was well-nigh exhausted within fifty years. Over a million acres were given away in each of the states of Wyoming, Montana, Colorado, Oregon and Washington; and over 200 million acres altogether were allotted. In 1904, when two thousand pieces of land were offered for settlement, no less than 106,000 persons made application for them. The demand was 53 times the supply. Under such circumstances land values were bound to rise. Land given away in 1875 now sells in some cases for \$300 an acre.

Large-Scale Farming and Tenantry.—With land high priced it is hard for a man with little capital to secure it. As a result men with capital are getting control of ever larger tracts, and then renting the land to tenants. Small owners do the best quality of work because they have a personal interest in it; they are careful not to drain the soil of its fertility, because they hope to own it permanently. Besides, they have the personal satisfaction of being their own boss. On the other hand, renters are slipshod in their methods; they work for the greatest immediate

gain regardless of soil deterioration; and they often feel a loss of self-respect in being under the dominance of another.

But those who are most alarmed at the tendency toward large-scale, rented land agriculture do not go sufficiently deep below the surface. Large-scale farming is likely to be done by the most capable farmers, just as all large-scale businesses require and get the keenest men. Large-scale farming permits a much greater subdivision of labor than small farms. This is not only more profitable to the owner but more satisfactory to the farm workers, because it simplifies and standardizes their tasks. On large farms machinery can be purchased in larger proportions and applied more economically by reason of the larger acreage. The owner himself can devote his time more completely to the business of management, and attain a position and profits more comparable to those of a factory manager.

As to the tenants, the statistics collected by the census show that most of them are young men who use the tenant system as a means of serving an apprenticeship at the farmer's trade while saving sufficient money to purchase land for themselves. There are few tenants beyond the age of forty, while farm owners are more frequently in age groups beyond the forty-year period. Although tenantry has increased from 25% in 1880, to 37% in 1910, we have not raised a landlord class, for 80% of the landlords own but one farm each. Neither are they absentee landlords, for three-fourths of them live in the same county in which they own farms.

In effect, tenantry is a partnership, with the older men furnishing capital and the younger the labor. As soon as the youngsters can put up a little capital they buy a farm and mortgage it for the remainder of the purchase price. These mortgages on the average are paid off in five years, and less than 1% are ever foreclosed. Tenantry, that is to say, is merely a reflection of the passing of free land, and is not creating a class of landlords surrounded by a class of potential peasants.

Moreover, the tendency to enlarge farms of more than 50 acres is counteracted by the contrary tendency toward decreasing the acreage of small farms. Of the two conflicting movements the latter is the more dominant. From 1850 to 1920 the

number of farms increased more than farm acreage, which means that small farms became more prevalent. In 1920 more than two-thirds of all farms ranged from 20 to 175 acres. This is a reflection of greater population, higher land prices, greater specialization in farm output, and in some areas of scarcity of farm labor. It is also due in part to the subdivision of farms or ranches for city suburbs, oil and mining developments. At any rate, the declining size of most farms is not an evil but an indication of greater national maturity demanding fuller utilization of soil. The day of pioneer agriculture has waned, while the era of an agriculture fitted for an industrial nation is dawning.

Status of Agriculture.—As we have said, agriculture is the primary industry. This statement may be demonstrated statistically by comparing agriculture with other industries as to the number of enterprises, capital invested, persons engaged and value of output. In 1920, the United States had $6\frac{1}{2}$ million individual farms, but only 291,000 factory enterprises, and 14,000 mines and quarries. In agriculture, nearly 80 billion dollars was invested, an amount almost double the investment in manufacturing and more than 10 times the sum invested in mining. The number of persons directly engaged in agriculture was nearly identical with that connected with manufacturing, and the value of agricultural products was but slightly inferior to the total value added to commodities by factory manipulation.

There is ample historical evidence that man may live by agriculture alone, but can depend upon manufacturing, mining and lumbering only if peace and transportation facilities are uninterrupted. Farmers at various times have suffered from the maladjustment of division of the national income, but the farmers' work is indispensable and they themselves are the most independent of all producers. The men who own and till the soil have a refuge in crises, a safe livelihood when other producers starve. Agriculture, therefore, is the most fundamental industry.

CHAPTER II

LUMBERING AND MINING

Lumbering

Introduction.—Lumbering and agriculture, once intimately interrelated, have been the warp across which have been thrust mining and manufacturing to weave the fabric of American industry. Lumbering commenced with Jamestown; it has been continuously prosecuted; and today it is one of the leading industries in the employment of men. For more than two centuries wood was the principal material in city construction, household, farm, and industrial equipment, vehicles and vessels, filling the place now taken by iron, steel and concrete, as well as a variety of recently developed materials. Moreover, wood was the most important domestic and industrial fuel, and strange as it may seem to urbanites, wood in enormous quantities still “keeps the home fires burning.”

Lumbering accompanied settlement from the Merrimac to the Columbia. New England forests, the first exploited, were followed by the forests of New York, Pennsylvania and the Lake States. Then with ax and saw the yellow pine forests of the South Atlantic and Gulf regions were attacked. More recently the lumberman has invaded the forests of the Rockies, the Cascades and Sierras. Only in the arid regions of America has lumbering been notably absent. From the 100th meridian westward to the crest of the Rockies scanty rainfall for the most part prohibited tree growth, but even within this area moister elevated portions possessed forests and have known lumbering. Everywhere else forests and lumbering have been a constant element in the community life.

Pioneer Lumbering.—Settlers in America for two hundred years hewed homesteads from the surrounding forests. To be

sure, there existed many natural clearings as well as those made by the Indians for agriculture and these were eagerly seized. But most pioneers cleared lands for farming by chopping or burning the encumbering trees. This was not entirely unremunerative labor, for the wood was used for shelters, utensils, furniture, tools and fuel. Yet about the only commercial products of this lumbering were potash, pearlash, and certain useful barks. Trees so certainly pointed to soil quality and water supplies that westward emigrants preferred forests to prairies. As a consequence, pioneer lumbering was a continuous feature of American life until the railroads revolutionized economic organization.

Farmer Lumbermen.—Steadily, as the frontier receded westward, farmers succeeded the pioneers. But since the pioneers seldom removed all the trees from a farm-place and since, even when they did, natural re-seeding eventually produced second growth of timber, the farmers generally continued lumbering as a winter or odd time job. Much of this was for the purpose of securing fuel or lumber for new houses, barns or sheds on or near the farm. With the coming of railroads and telegraphs, farmers found a commercial market for their winter lumbering in the needs for ties, poles, and bridge timbers. Near mines there was a market for props. Townspeople, too, bought cordwood for fireplaces or stoves. To this day lumbering for such markets as these is part of many farm operations.

In New England and the Middle West much interchange of labor has taken place between farms and lumber camps. Likewise, in the mountains of the far West lumber operators share the same labor supply at different seasons with farmers, ranchers, and mine operators.

Commercial Lumbermen.—Commercial lumbermen not only trod upon the heels of pioneers, but often themselves were the advance guard of settlers. These lumbermen made logging a special business, carrying it on, not in connection with farms nor for the primary purpose of clearing land, but for the definite aim of securing saw-logs in the unsettled forests.

Such commercial lumbering began in New England as early

as 1623 and has continued until today not only in New England but in every other forest region of America. As practiced in the United States commercial lumbering has been destructive; therefore, from time to time, the area of greatest activity and largest output has changed.

Regional Specialization.—Each forest region has produced a particular tree and developed methods of lumbering, logging, and transportation peculiar to itself, although all the regions produce and log certain varieties of trees and use certain methods akin to those of others.

In New England and the Lake States the white pine was the principal lumber tree, while in the South the yellow pine has been the leader. On the Pacific Coast precedence has been given to the Douglas fir. Technically, these all were soft woods. The woods classified as *hard*,—namely those derived from trees that shed their leaves,—although found in all regions, have been derived primarily from the forests of the Central States and particularly from the Appalachian Mountain districts. Although no less than twenty-nine species contribute valuable amounts to the total for the United States, seven species¹ of timber constitute the bulk of the present lumber cut, yellow pine alone forming more than a third of the total. In Georgia, Alabama, Mississippi and Texas between 80% and 90% of the total cut in 1925 was from yellow pine, whereas in Washington and Oregon in the same year about two-thirds of the cut was from Douglas fir. On the other hand, Maine was the leading state in the production of balsam fir, Michigan in that of maple, Arkansas in that of oak, and Indiana in that of walnut.

In part because of the differences in the kinds of trees felled, but more because of the variations in climate or topography, each forest region has developed methods of its own. In New England and the Lake States logging always has been a winter task, the logs being hauled over snow roads by oxen, horses or tractors to a concentration point, and spring floods being utilized to float logs to saw mills. In the South Atlantic forest cutting generally has been an all year job with railways, either temporary or

¹Yellow pine, Douglas fir, western yellow pine, oak, hemlock, white pine and red gum.

permanent, employed for transportation. Southern swamp forests gave rise to cable haulage and boat transportation. In the mountains of the West flumes or slides bridged chasms and girded steep slopes. In the far West the industry utilizes also the methods of cable haulage, railway transportation, and floating in streams.

The Central Forest.—In the southern Appalachians, and in the southern sections of Ohio, Indiana and Illinois together with the Ozarks, there are forests of hardwoods. To be sure, hardwoods are sprinkled through all the forest regions but it is only in the Central Forest that they grow in solid ranks. Originally the terms “hard” and “soft” indicated physical properties of wood, but they are no longer exact in that sense. Today the terms more nearly differentiate on the one hand the trees that shed their leaves and on the other the evergreens which do not lose foliage in winter.

The hardwood forests nowhere consisted of unmixed stands of a *single species*, but oak, chestnut, walnut, cherry, hickory, basswood, and the like grow side by side; some of the hardwood forests included also scattered softwoods such as white pine and hemlock. Most of the hardwoods were used for furniture, vehicles, implements, posts, ties or fencing. Some of them, chiefly oak, chestnut and hemlock, having a bark high in tannin, have been utilized in the leather industry. Since the hardwoods usually grew in good soil the removal of the trees has been permanent; the soil has been more useful to man for the growing of crops than of trees. About 60% of the area of the central hardwood forest has been cleared for farms.

For the most part, the hardwoods have been distributed among a large number of owners so that small-scale logging operations have been more general than in other forest regions. The methods of logging hardwoods were as various as the owners.

Competition Between Regions—Effect Upon Forest Resources.—Since the opening of the Erie Canal there never has been a time when the lumber markets have not been able to command the supplies of more than one region, and the resulting

competition always has reduced the peak of lumber prices. While consumers have benefited, they have done so at the sacrifice of resources, for high grades at low prices have excluded low grades from the markets and advanced the rate of felling high grades in the forests.

By reducing the freight rates on long-haul lumber business, railroads have increased the regional competition. The railroads tapping the southern forests adopted this rate policy to the benefit of the mid-western market, and likewise the Hill roads did it for west coast lumber entering Minneapolis and Chicago. The result has been that the lumbermen of each forest region have sought markets outside their own domain long before the market necessities normally would have caused a search for lumber in the distant region. Temporarily, the favored market gained the advantage of low prices on high grade lumber but the consequent waste of timber has been appalling.

Of course, there have been sound economic reasons why some lumber always has entered markets from a distant forest region long before the region as a whole has been called upon. The differences in costs of production within any one region, even one favorably situated near a market, have always been greater than the freight differential from a distant region. For instance, the lowest cost lumber of Oregon could sell against the highest cost lumber of Pennsylvania in the Pittsburgh market because the freight rate was less than the differences in cost. But the lowest cost Oregon lumber could not have competed with the lowest cost Pennsylvania lumber, if the Pittsburgh market could have been satisfied by the low cost Pennsylvania producers. The demand in Pittsburgh, however, was so great that the price of lumber was set, not by the lowest Pennsylvania producers, but by those high enough up the scale to admit the lowest cost Oregon lumber in competition. No one could object to this sort of early call upon a distant region, but the movement has been artificially and detrimentally stimulated by low long-haul rates.

New Regions of Supply.—Our earlier forests were in the 16 states east of the Mississippi and north of the Ohio where at present half the population of the United States lives. Lumbering

in these forests, therefore, had all the advantages of nearness to market. But the cutting areas constantly have retreated from the center of population, so that in 1925 the area of densest population, although it consumed nearly half of all the lumber, supplied from its own forests only a fourth of its own requirements. On the other hand, the principal lumber shipping regions are the Pacific States, the South Atlantic and the Gulf States; that is, from areas of small density of population. The South and the West grow the timber for the Central and Northeastern States. The effect that changes in location of the principal cut have had on nearness to consumer is indicated in the following table:

RELATION CENTER CUTTING TO CENTER POPULATION

Date	Center Cut	Center Population
1850-1870	East	Eastern Ohio
1875-1900	Lakes	Central Indiana
1900-1914	South	Central Indiana
1914-1915	Pacific	Western Indiana

In 1914 the average rail haul of lumber was 360 miles; but in 1925 it was 725 miles. For softwoods which comprise the bulk of the lumber the average rail haul in 1925 was 840 miles. For the North Pacific softwoods the average rail haul was 1,275 miles. This is significant, for it is this softwood that is the chief reliance of the future.

New Regions of Cut Increased Freight Charges.—The increase of distance between source and market has been accompanied by a change to a more expensive form of transportation. The earlier logging and lumber shipment was done by water, the later by railroad. Indeed at first, the whole log was carried by water to the final market where the sawmills were then located, a possible arrangement because the bark, edging and trimmings were sold for common fuel. But improvements in transportation and the use of coal fuel soon drove the sawmills to the forest. Finished lumber then went by the New England rivers, Long Island Sound, the Champlain-Hudson route, or the Great Lakes and Erie Canal, to the great markets at Bangor, Boston, New York, Albany, Burlington, Buffalo, Tonawanda, and Chicago. What has happened in the Chicago market is typical; in 1875

Chicago received 81% of its lumber by water, while in 1913 only 9% came by that route. By 1927 barely 15% of the total lumber shipped in the United States was borne by water. Water transportation in the earlier period was seldom for long journeys and always at a relatively low charge. It is estimated that equal rail hauls would have cost from twice to ten times the water burden. Yet, in 1927, nearly three-fourths of all lumber was carried between states and regions by railroad.

The increased cost resulting from change in the mode of transportation has been augmented by the much longer hauls. Prior to 1840 the average transportation charge was from \$1 to \$3 per thousand board feet; by 1900 it had risen to \$9; and in 1920, so far as west coast lumber was concerned, it reached \$20. In 1925 the average freight charge was \$12. The freight charge alone on lumber in that year was greater than the price of finished lumber at the mill in 1899. It is estimated that the Lake States, the leading producers between 1875 and 1900, now pay a lumber freight bill of 6 million dollars a year, while the total national freight bill for lumber in 1925 was 400 million dollars. That this situation will continue is indicated by the fact that of all the remaining saw timber in the United States, New England has but 2%, the Lake States 5%, and the South 10%; while the Pacific Coast States have 51%.

Other Factors in Lumber Prices.—Timber depletion has had the natural effect that stumpage values have risen. Although stumpage values even now do not represent the cost of growing a tree for a hundred years (or less), yet they are far beyond the point where standing timber can be considered a free gift as was once the case. Increased stumpage values, of course, mean that the cost of lumber raw material has multiplied.

The cost of logging also has mounted, because cutting has been pushed into rough, inaccessible country. Moreover, the wages and maintenance charges for logging crews have kept pace with other augmentations in the cost of living.

Capital equipment in the form of machinery has advanced progressively in the woods as it has in factories, but in the forest depreciation charges are greater than in workshops where the

hazards are less. All of these factors are reflected in higher lumber prices.

In addition the cost of operation of wholesale and retail lumber-yards has had a startling rise because services demanded have become more detailed and complex. It is no cause for wonder then that our pocket books are flattened when we buy wood in any form. The average value of lumber at the mill per thousand board feet was \$11.13 in 1899, and \$28.02 in 1925. For particular hardwoods the advance has been more startling. Walnut, for example, has jumped from \$36.49 to \$111.53, and ash from \$15.84 to \$48.46. Among the softwoods the sharpest rise has been for sugar pine and cypress, the former having risen \$32, and the latter \$27.

Production of Lumber.—The highest peak ever reached in American lumber production occurred in 1906. This date is important because in the first quarter of the 20th century as much lumber was produced as in the entire 19th century. In this quarter century the lumber production alone, to say nothing of timber cut for other purposes, was in quantity comparable to about half the existing lumber resource. The volume of production for the remaining years of the quarter even at a rate less than that of 1906, foretakens actual stringency in the future. Consequently, we must either reduce still further our annual cut and per capita consumption or take steps to augment the supply of timber.

Reduced Consumption of Wood.—Indirectly, the high price of lumber already has reduced our per capita consumption of wood, and hence relieved somewhat the strain on the forests. Men want utilities, not a material. For example, men go into the market to buy fencing, furniture or packages; it is immaterial to many buyers whether the commodity be made of wood or wire, steel or pasteboard. Price and utility determine the choice between a wooden or a steel bed, a wooden or fiber packing case. So many substitutes have been created for former wooden articles and these substitutes have been so aggressively pushed on the market, that our national per capita consumption of lumber de-

clined from 504 board feet in 1907 to 375 board feet in 1915. That this curtailment has been reflected in the lumber cut is indicated by the fact that in the same period the cut shrank from 37 billion board feet to 30 billion.

Timber Ownership: Public.—Before 1891 all of our forests were either in private hands or were open to exploitation by private individuals. This led to reckless cutting. The waste of forests was increased by fire which burned annually an amount of wood equal to 3% of our yearly cut. Unwise taxation and sacrifice of woodland to offset excessive carrying charges further depleted our wood resources. The extravagance of our use of forests was ignored until the white pine of New England and the Lake States was actually exhausted so far as practical large scale lumbering was concerned.

The disappearance of the white pine gave us a national shock. The interest and discussion aroused by this calamity culminated in 1891, when Congress authorized the President to withdraw selected areas of forest land from private exploitation.

Reservation Policy.—The words “forest reserves” have a psychological interest because they indicate the original purpose of national forests, namely, to withhold them from use until future times. This idea is definitely—and unfortunately—expressed in a clause of the New York State Constitution which as a result of incautious revision, entirely prohibited the cutting of trees on the public lands of the state.

Gradually public opinion inclined to the view that the purpose of reserving forests for the future was not inconsistent with their use in the present. It was seen that if annual cutting did not exceed annual growth, the forest as a whole could be retained for unborn generations while existing current demand could be partially met. Professional woodsmen proved also that judicious cutting was beneficial to the forest, for it removed trees ripe for the ax and allowed room and light for young trees to mature. Furthermore, it was learned that the forests could be opened to grazing without harmful results if the grazing were regulated by public authorities.

Recognition of these facts removed much opposition to the reservation policy and enabled Congress in 1897 to extend the area of the reserves and authorize the proper use of the public forests. Eventually in 1907, to escape the implication of the name "reserves," Congress changed it to "national forests."

By 1922, due to various additions to the national forests proclaimed by successive presidents, together with similar state forests, as much as 20% of all standing timber had been brought under governmental authority. The total area in reserves, 180 million acres, is larger than any one state, larger than all New England plus New Jersey and Delaware, and larger than the combined areas of New York and Pennsylvania.

Although the principal aim in the creation of public forests in America has been to restrict wholesale destruction of a natural resource—an object made necessary by the rapid depletion of woodlands under private ownership and operation—to this main purpose others have been added. Among them are the maintenance of cover on the headwaters of streams used for power, navigation or irrigation, the prevention of floods, the preservation of wild life, the saving of places of great scenic beauty, the regulation of grazing, and the provision of resorts for out-of-door recreation. In addition to the action of the federal government, a few of the states, notably Oregon, Minnesota, New Hampshire and Louisiana, have either established "state forests" or have brought private forests under public control; and this movement is spreading rapidly.

Timber Ownership: Private.—But regardless of their size or importance, our public forests are insignificant compared with those owned by private citizens. Four-fifths, or 80%, of our timber land is private property. The owners are numbered by thousands and the acreage by millions. Curiously, however, most of the thousands of owners can claim but a few hundred acres each while a few owners hold title to the remaining millions of acres.

Concentration of Ownership.—About 95% of the small holders are east of the Great Plains, the farmer with his wood-

lot being the conspicuous type. The only large timber acreages in New England are those which have been consolidated in the hands of a few large paper companies to secure supplies of pulp wood; a few such companies control about half of the pulp wood of New England. Southern cypress is in the hands of an extremely limited number of holders, but the yellow pine ownership is well distributed. Owners of large tracts are conspicuously absent in the Central hardwood forest. On the other hand, the Lake States show a remarkable concentration of the most valuable species.

The most prominent concentration of forest ownership is in the Rocky Mountains and along the Pacific Coast. Three large corporations out there hold between them 11% of all privately owned timber in the United States.

Limited control of a great natural resource where it exists is still further concentrated by community of interest among the largest owners, and by the strategic location of their holdings. Not only is the most accessible timber held by them, but their lands are so arranged as to block others from admission to natural outlets. The control of the large holders, therefore, extends far beyond the rights inherent in their own property, and the continued depletion within each forest region enhances the degree of concentration because generally the smaller holdings are exhausted first. Yet, strange as it may appear, these facts have not led to timber monopoly. The industry is fiercely competitive.

Industry Competitive Nevertheless.—This is due first of all to the large number of small holdings in each region; Washington and Oregon alone have 24,000 such titles. The large number defies any attempt at concerted action for selfish purposes. Forest operators are traditionally a highly individualistic and independent set of men, a characteristic which makes it difficult to organize a monopolistic enterprise that depends on cooperation. Each region, too, offers competition between widely held inferior species and concentrated superior ones. Monopoly generally depends upon large scale production, but in the timber business when a region begins to decline or when cutting species are not found in stands, large-scale operation is not so efficient as small.

Between regions there is a continuous war for the control of common markets; thus, the Southern, Pacific Coast, Rocky Mountain, and the dying Lake regions all struggle for the middle west consumers.

Our national forests, although constituting only a fifth of the total timber, nevertheless check and balance untoward movements in the other four-fifths. Neighboring countries—Mexico, and particularly Canada, the world's second largest lumber producer—could seriously threaten any timber monopoly that might arise in the United States. Our imports, particularly from Canada, have increased greatly in the last quarter century.

Finally, outside the lumber industry makers of wood substitutes have made serious inroads upon the lumber trade and most effectively prevent lumber prices from reaching "all the traffic will bear."

Therefore, despite concentration of timber ownership within regions, there are few industries within the nation so highly competitive. Indeed, since the competition is conducive to depletion and waste of the forests, it is a questionable virtue. Of the two curbs to it—increased private monopoly or more national forests—there should be no hesitation by the public in favoring the latter.

Manufacture of Lumber: Logs.—In a sense the manufacture of lumber begins with the cutting of the trees and the separation of trunks into logs. In support of such a view is the fact that often the same men control the logging operations, including transportation, and the saw mills where the logs are converted into lumber; while the further manipulation of lumber is left to other groups of men. Yet it is customary to consider all phases of logging as a raw material industry while wood manufacture is deemed to commence with the saw mills.

If a Kennebec logger of 1800 could return to our present forests he would see little that was strange to him. Logging is a crude task performed far from centers of population and, of course, by our destructive practices which ignore replanting, cannot permanently be established in one place. Hence, machine methods have made slight headway against hand work. The ax and hand

saw still are the sole instruments for felling trees. For moving the logs some machinery has been introduced, steam engines or tractors supplying the power. However, the compelling motive for this machinery has been the great weight of logs, especially on the Pacific Coast, rather than a deliberate effort to replace hand methods.

The principal products of logging camps are saw logs, shingle, stave, and heading bolts, poles, mine timbers, spars, fence posts, hewn railway ties, and stock for making wheels, handles, and excelsior.

Manufacture of Lumber: Sawmills.—The most ancient method of producing lumber from logs was to hew the timbers out with an ax, and to split the timbers into boards. The first improvement was the whipsaw which in turn yielded to the frame saw. The latter was a rectangular wooden form with a saw attached between the opposite short sides. To manipulate this tool the log was roughly squared with a broad ax and then elevated on a seven-foot trestle or over a pit. One man stood above on the log and another below pushing and pulling the saw through the log, cutting on the downward stroke. In this way about 200 board feet of lumber could be sawed per day.

The frame saw next was enlarged and installed in sheds where water power replaced the two hand workers. This power frame saw had an output ranging from 500 to 1,000 board feet per day. Sawmills of this type were common in all the American colonies and throughout the first quarter of the 19th century. The mills were both commercial and "custom," the latter sawing patrons' logs to order for a commission.

Between 1826 and 1850 steam began to supplant water for the operation of sawmills. Circular saws, whose continuous cutting saved the waste of a reciprocal frame saw, which cut only on the downward stroke, invaded the mills after 1836. At the same time there appeared mechanical devices for handling the logs from the sawmill pond to the saw carriage, as well as for moving the carriage itself. After 1850 double-edged saws were introduced to save one trip of the carriage, and about 1880 thin band saws were invented to reduce the width of the cut and con-

sequent waste of good wood. Finally gang saws—which consisted of a row of saws set in a frame and as far apart as the desired thickness of the board—were evolved. Their economy consisted in sawing a whole log at one forward movement of the carriage.

The carriage in every case had to move the log slowly against the saws in order to allow time for the cutting action; but if the carriage returned at the same speed much time was lost. Consequently a mechanism was devised to jerk the carriage back into position to receive another log.

Movable belts, chains and tables were introduced to carry the sawed lumber to the storage yard. In the yard, too, machine transport superseded hand haulage. Curing of sawed lumber was hastened by steam-heated drying kilns. Since 1900, and rapidly since 1910, electric power has been competing with steam in sawmills. A modern sawmill may produce as much as 100,000 board feet of lumber per day.

Large mills of the modern type are most frequently encountered on the Pacific Coast where the size of the logs requires mechanical handling and where lumber holdings are largest. About a third of the mills on the west coast are large scale. In the southern states for similar reasons large mills are often seen; about a fourth of the mills there would be classed as large. Elsewhere hardly a tenth of the mills could be called large and in New England it would require long diligent search to find a large sawmill.

The large mills saw about two-thirds of all the lumber in the country. Yet in the absence of reforestation the day of the large mill is numbered. With the passing of big timber and large logging operations it will go.

Small mills have flourished in spite of the advantages of large scale production. The small mill fits the needs of limited woodlots, isolated stands and second growth tracts. Some mills are so little that they are portable. They follow after larger logging operations and clean up the odds and ends.

Sawmills produce rough lumber, pickets, shingles, lath, sawed railway ties, and stock for the manufacture of barrels, spools, pencils, penholders and veneer.

Attached to sawmills or operated as separate units are planing mills. From rough lumber these establishments produce dressed lumber, sash, doors, blinds, interior woodwork and molding.

Manufactures from Lumber.—Most of the materials from sawmills are used for buildings or for further manufacturing in other industries. The use of wood in all kinds of buildings is well known. But that wood enters into manufacturing to a greater degree than any other commodity except iron or steel, is realized only upon investigation. For if the commodity produced is not partly wood, at least in the factory equipment, from the order clerk's pencil to the shipping crate, wood is an essential.

What becomes of the lumber when it leaves the millyard is determined by the nature of the board itself. Certain qualities found in particular woods fit them for specific uses. The durability of cypress—"the wood eternal"—and of chestnut, oak, or mesquite makes them highly desirable for the frames or outside finish of dwellings. On account of their strength white or yellow pine are used for bridges and other places where heavy burdens must be carried. The resistance to bending found in white oak, fits it for columns or pillars. Furniture requires a wood that is hard, non-shrinking, and capable of taking a high polish. Mahogany, oak, chestnut, walnut, maple, and pine all possess these qualities. Since for furniture, too, beauty of grain is an essential feature, we find that the unusual, distorted grain known as "bird's-eye," sometimes discovered in maple, makes it highly prized for beds, chairs, or bureaus. Hickory's toughness marks its place as a wagon material, while the elasticity of ash makes it desirable for shafts or athletic appliances. The color of ebony, the odor of sandalwood, the fire-resistance of California redwood, the freedom from insect pests noticeable with red cedar, all these are peculiar qualities that determine why each of these woods is sought for special uses.

Chemical Constituents.—In addition to the foregoing, many woods contain chemical constituents that are of industrial significance. Thus the bark of oak and hemlock are rich in tannin

and so have been employed for years in tanning hides or skins into leather. Sumac is utilized for a like purpose. Other woods have the property of acting as coloring agents, hence are used for dyeing leather and cloth. The osage-orange, barberry roots and inner bark of the black oak yield a yellow color while red gum gives purple and the flowering dogwood gives red. All of these have been employed in the past for dyes.

Two Types of Wood Manufactures.—The manufacture of wooden commodities from the lumber turned out by the saw-mills, is carried on in all types of wood-working plants by analogous methods; sawing, planing, lathe processes, glueing, polishing and assembling comprising the essential operations. The industry, however, falls into two groups, one in which skilled craftsmanship plays the most important part, and the other where volume of output from automatic machines is the principal characteristic. Wood-carving and cabinet work illustrate the first, while the manufacture of matches or spools may be taken as typical of the second. Of the former, the articles tend to be manufactured where they are used, partly because their high value limits their sale to large communities, and partly for the reason that it is cheaper to ship carload lots of lumber than it is the bulky, easily broken, completed commodities. Nearly every city has its needs fulfilled by its own group of skilled men.

Even in this branch of the business, machinery has displaced men to such an extent that a few communities are becoming famous for particular products, and by transporting them in the "knock-down" condition to distant markets, have largely superseded the older local industry in each consuming center. In this way Grand Rapids, Michigan; Sheboygan, Wisconsin; Gardner, Massachusetts, and several towns in Indiana, Tennessee and North Carolina have attained fame for their wood-working factories.

Of the second group of plants dependent upon automatic machinery, the most important considerations are abundant and cheap raw materials plus cheap power. The factories as a result are located as near the forest as possible and as a rule at a convenient water power site. Since the product is usually small

—clothes-pins, rolling-pins, spools, matches, and the like—and can be closely packed, distance from the market is not an elementary consideration. As machinery dominates the entire industry more and more, the distinctions based upon craftsmanship disappear while raw materials or markets become the important elements.

Substitutes.—As long as lumber was cheap no search was made for substitutes, but when its price advanced, that investigation began. It was quickly proved that wood was not indispensable but that many other materials of perhaps superior serviceableness could be secured. As a consequence, steel has been used for furniture; concrete for structural purposes; paper for boxes or crates; wire instead of wood has come into favor for fences; iron or concrete for posts and poles; asbestos, slag, slate, and tile replace wood shingles; metal lath and window-casings appear where wood once was first choice; metal automobiles are the successors of wooden carriages; iron and steel ships, and railway vehicles have driven wooden vessels from the seas and cars from the tracks. In short, for all its important uses wood has a competing substitute. Where wood is retained it is often not employed in the solid form but in thin sheets called veneer. Thus costly woods cover cheaper varieties. The shift from wood has been so rapid and so far reaching that those engaged in the wood industries fear for their existence. However, probably a balance will be struck between wood and its competitors, each serving a definite field. It is a national blessing that we are not as dependent upon wood as we once were.

American Mining

Colonial Mining.—That the lure of gold and silver was one of the impelling motives in the exploration of the Americas is well known. Not only the Spaniards but the British, too, sought quick wealth. The Jamestown settlers wasted valuable energy and well-nigh perished because they esteemed “fool’s gold” higher than corn. In Connecticut even so hard-headed a business man as Governor Winthrop searched for precious metals between 1650-60 in the lower Connecticut River Valley. The hope that gold

would be discovered was never entirely quenched among the colonial settlers.

However, the attention of the colonists soon swerved from the metal that glitters to the prosaic clay from which bricks or tile were made. Clay digging was the first important American mining industry. Practical considerations also forced our forefathers to mine iron bog ore. Clay and iron mining were the only types of mineral exploitation of any importance in colonial America.

To be sure, the far ranging French noticed, reported and, to a slight extent, worked mineral deposits in the Mississippi Valley. Thus, in 1650 or thereabouts, the Jesuits came upon the copper resources near Lake Superior and in 1673 Joliet and Marquette noted coal deposits in the reports of their travels. A few years later Father Hennepin, indefatigable explorer, printed on his map the location of a coal mine on the Illinois River above Fort Crevecoeur. LeSeur in 1700 commented upon the lead and iron of the upper Mississippi, while a miner, Julien Dubuque, actually operated a lead mine from 1788-1809 near the town that bears his name. John Law's Mississippi Bubble sent in 1720 one, Renault, and a mineralogist named LaMotte to the Missouri lead district where Mine LaMotte has been continuously productive since 1798.

Meanwhile, the British had discovered small copper deposits in Maine, New Hampshire, Vermont, Connecticut and New Jersey. The first chartered mining company in America was started in 1709 to exploit the copper deposits at Simsbury, Connecticut, and for forty years thereafter copper was produced at that spot. The mine then became a convict prison, following Athenian precedent. The Schuyler Mine of New Jersey began business in 1719 and sent copper ore to England, mistaking it for iron ore. At the mid-century this copper mine and others in New Jersey gained considerable notoriety. During the Confederation the copper mines of Vermont (1785), Connecticut (1785), and New Jersey (1786) furnished the material for coining state cents. Both Massachusetts (1786) and New York (1787) also minted copper coins from metal obtained in adjacent states.

Post-Revolutionary Mining.—Between the Revolution and the Civil War two mining features were noteworthy. One of these was the rise of iron mining to a position of primary importance; the second was a series of booms in gold, coal, copper mining and petroleum.

While colonial iron *mining* had been encouraged by the British, iron *manufacture* competing with their own had been discouraged and at one time prohibited. At the close of the Revolution, after a temporary depression from war production, our iron manufacture expanded with a rapidly growing domestic market and caused an increase in iron mining. This was true of all the iron making nations, for between 1800 and 1850 the world output of iron multiplied by eight times. By 1850 21 of our 31 states were mining and manufacturing iron, producing one-sixth of the world's output. At that time, however, Britain was turning out three times as much iron as we were.

Southern Gold Boom.—Flecks, grains, and nuggets of gold both in colonial days and immediately after the Revolution, had been discovered from time to time at the bases of the eastern mountains from Vermont to Virginia. Larger gold discoveries in North Carolina in 1804 started a search all through the South for the precious metal, and workable amounts were found in Virginia, North and South Carolina, Alabama, Tennessee and Georgia. Each new discovery produced temporary local enthusiasm but for the most part, the early southern booms were intermittent, prospecting being a pleasant vacation tinged with speculative excitement.

Native gold was first coined at the mint in 1825. Five years later the southern mines for a brief period were turning out about one million dollars' worth of gold per year. This led to the first serious but ineffective attempt to place the nation on a gold standard money basis, the agitation being led by southern representatives in Congress. It also produced a demand for mints in southern states. In 1838, to satisfy local jealousies no less than three mints were located in the south, one at Charlotte, North Carolina; another at Dahlonega, Georgia; and a third at New Orleans.

California Gold.—The great gold boom, of course, was that of 1849 following the discovery of the precious metal in our recently acquired California. Gold had been noted in California long before by the Franciscans, French and British visitors and others, but it remained for a contractor working near Fort Sutter to startle the world. It was in February or March, 1848 that the first gold strikes were made, but it was not until August or September that the news broke upon an astounded East. In '48 miners from Mexico, Peru, Chile and across the Pacific from the Sandwich Islands and China rushed to California. The following year the eastern Americans, British, French and Germans flocked in hordes to the glittering promise on the Pacific. What ensued is familiar to everyone. Down to 1853 our southern gold fields furnished an aggregate of 16 millions in gold, while during the first six years of California production, that state yielded 207 million dollars of the precious dust. The contrast in these figures explains the national hysteria.

The sudden wealth in California reacted upon mining in all the older states and caused prospecting in all our national possessions. Out of this came discovery not only of more precious metals but of the prosaic yet more valuable industrial minerals. Beyond the bounds of mining this search produced new political territories and states and expanded agriculture, forestry, manufacturing and commerce. It made the Pacific and Rocky Mountain regions valuable and so helped to mould a continental nation.

Anthracite.—Meanwhile, the industrial east had learned the usefulness of anthracite coal. The first discoveries of anthracite seem to have been in Rhode Island in 1760. Two years later a company of Connecticut pioneers settling in the Wyoming Valley, Pennsylvania, came upon anthracite, and one of them, Obadiah Gore, a blacksmith who burned anthracite in his forge, appears to have been the first man to utilize this coal as a fuel. Other men experimented with anthracite but it was not until after 1820 that the fuel was popularized and a boom in its mining started. Although it lacked the spectacular features of a gold boom, this coal mining was fully equal as an economic revolu-

tion, since it may be said to have inaugurated our modern American industrial era.

Copper.—The first copper boom commenced in 1844, following the cession of the Lake Superior mining district by the Chippewa Indians. Copper had been mined there ages before by Indians, as is attested by deep mines and relics found in burial mounds. The Indians actually in possession in 1843, however, had no knowledge and no tradition of copper mining. The first white man to operate in Michigan was Alexander Henry, who opened a mine in 1771 near the forks of the Ontonagon. It is said that the shrewd Benjamin Franklin had heard of the copper deposits and so in the Treaty of Paris (1783) manœuvred the British into placing the American boundary north of the mines. For years this Michigan region was too wild and remote to warrant attention, but when it was opened in 1844 there was a wild scramble to locate claims. The first company organized was the Lake Superior Copper Company among whose trustees were David Henshaw, then Secretary of War, and Lemuel Williams, both of Boston. Capitalists of Pittsburgh and Boston formed the "Pittsburgh and Boston Mining Company" which began operations the very year the area was opened, and so in actual mining preceded the Lake Superior Copper Company. Following the lead of these two companies all the features of a "gold rush" took place, even to the speculative and often fraudulent floating of companies in eastern cities. The fever lasted until 1847 when six companies were left in control of the field. After the opening of the "Soo" Canal in 1855 the area took on new importance and soon advanced to the position of the premier copper district of the world, a position it held until jostled first by Montana and then by Arizona. Nowhere has so great a quantity of high grade copper been produced as in Michigan, much of the material being native copper. All other copper deposits have been chemical combinations of copper, with sulphides predominant.

Petroleum.—"Col." Drake, a conductor on the New Haven Railroad, was employed by a group of New Haven oil promoters in 1859 to drill an oil well in Oil Creek, Pennsylvania, where sur-

face collections of petroleum had been exploited for many years for medicines and illuminants. Drake's well, when completed, yielded 20 to 30 barrels of oil per day. This news flashing over the nation produced in Pennsylvania most of the effects that the news from Sutter's Fort brought about in the country north of Sacramento. From time to time, as new oil fields have been opened, the wild rushes have been repeated.

Oil fields are ephemeral; they begin with a hectic boom, become humdrum and eventually decline to exhaustion. Although the complete cycle has never yet been run in our larger producing regions, the output from each region has varied greatly at different times. Associated with petroleum is natural gas; it is found in the same areas and often in the same well with petroleum. From 1859 to the present day these two mineral resources have ranked among the most valuable the nation possesses.

In all this advance in mining one factor should not be overlooked. From 1830 onward the researches of states and federal geologists have defined the boundaries and directed the exploration of mineral resources. The contributions of geologists to mining are immeasurable.

Since the Civil War.—

I. COAL.—Just as anthracite was our principal industrial mineral fuel before the Civil War, so bituminous coal has been the leader since that conflict. Exploitation of the coal beds near the Ohio began long before the mid-century; indeed, from 1830 the output of the two kinds of coal was about equal. From 1869 onward the production of soft coal far exceeded that of hard coal; it was double that of anthracite by 1889, three times as great in 1899, four times as great ten years later and five times as great in 1912, keeping about that ratio ever since. The reasons for this situation are the vastly greater area of soft coal, its wider distribution throughout the nation and its use as an industrial fuel, its output thus pacing industrial expansion. In 1829 the nation used about one-fiftieth of a ton of coal per capita, for wood and charcoal than were the principal fuels. Today, after ninety years of industrial progress, our consumption is $5\frac{1}{4}$

tons per capita. While population has increased eight times since 1829 our production of coal is 2,000 times that of the earlier date. Anthracite since the nineties has been primarily a household fuel, nearly all of it mined in a little corner of the one state, Pennsylvania. Its output has varied only slightly since 1900.

In the last half-century coal became the principal mineral product of America, eight times as important as iron, which had before been foremost, and almost fifty times as valuable as gold and silver.

2. IRON.—Iron, too, has jumped in production consequent to the discovery in 1844 of the vast ore bodies close to Lake Superior and the availability of these great deposits afforded by the opening of the "Soo" Canal in 1855. The great national expansion of the last seventy-five years created an enormous demand for iron and steel, which in turn, induced a rapid advance in the mining of iron ore. This is evidenced by the increased production of iron ore from 260 pounds per capita in 1879, to 1,160 pounds per capita in 1919.

3. GOLD AND OTHER METALS.—On the eve of the Civil War gold miners of California found that the easily obtained free gold was apparently about gone. The efforts of individual prospectors and miners were necessarily supplemented by capitalistic lode mining or the equally expensive hydraulic or dredge operations. So the bold pioneers with little capital except their energy pushed into new country to the north, west, east and south to prospect for new supplies of native gold. They found it in Idaho, Montana, Colorado and Nevada. The latest American gold rush occurred in 1927 when a couple of boys observing gold in a gopher hole at Weepah, Nevada, started a stampede for that desolate spot. In this last frontier two waves of migration met, it may be remarked, one pressing east from California and Washington, and the other taking the traditional westward course from the Mississippi Valley and Atlantic Coast.

Not only gold was discovered and mined in or near the western mountains but also silver, copper, lead and zinc. The technological strides in the metallurgy of these minerals after

the Civil War is well-nigh unbelievable. The advances in copper technology rivalled the better known achievements in respect to iron. While the Michigan copper often was native metal the copper of Utah in some cases yielded only 22 pounds of metal per ton of material yet because our metallurgist had so refined processes even this lean ore was mined at a profit.

Mining has been called in America the "prow of civilization." In the wake of the western mining booms there surged agriculture, forestry and statehood. The economic influence of a mining area is all out of proportion to its age or population. A small mining community may produce as much surplus wealth as a much larger, longer settled agricultural or manufacturing district. For example, 100,000 mines in the Inland Empire in the one decade of the seventies produced as much surplus per year as came from one and one-half million people in Kentucky or Ohio after two generations of settlement.

4. QUARRYING.—The growth of population since the Civil War has stimulated those stone and clay industries that are correlative to masses of people. Limestone, granite, and trap rock (basalt) for buildings or roads, and clay for brick, tile or pottery, depend for prosperity on the density of the population. In addition, one new variety of stone mining has been opened and advanced, that of phosphate rock for fertilizer. Phosphate rock has been mined, manufactured and largely used in the south.

General Economic Characteristics of Modern Mining: 1. Leadership.—Coal mining is the principal mining industry in America. The two kinds of coal together account for nearly half the values produced by all mining and employ close to three-quarters of all miners. Soft coal mining alone represents more than a third of the value of all minerals and more than half of all the wage earners connected with mining or quarrying.

Next to coal stands petroleum and natural gas. These with coal, in values of product and numbers of wage earners, are far ahead of all other kinds of mining.

Of the metals, iron mining is the leader with copper a close second, followed by lead and zinc. Gold and silver mining trail in the rear.

Limestone quarrying leads the stone industries, being far in advance of granite, sandstone, phosphate rock, trap rock, slate and marble, which rank in the order named.

In only five states ² is mining entirely negligible, but the total value of the mineral product of twenty-three states accounts for no more than 4% of the total for the nation. At the other extreme stands the state of Pennsylvania, whose mineral output is twice that of any other state and equals a fourth of the total for the entire United States. Pennsylvania is the first in rank in seven ³ different kinds of mining or quarrying. The other leading mining states are West Virginia, Oklahoma, Illinois and California. Mining, except in the case of some soft coal, is a mountain industry. Mineral deposits are a result of the same tremendous forces whether cooling, heat, or pressure has wrinkled the earth's surface. Hence, the Appalachians, Ozarks, Black Hills, Rockies, Cascades and Sierras are highly mineralized.

2. Localization.—Individual minerals show a high degree of localization. For example, soft coal mining which is carried on in thirty states nevertheless draws upon two, Pennsylvania and West Virginia for 60% of the total value of all produced, while the whole commercial output of anthracite is drawn from an area of 500 square miles in eastern Pennsylvania. Petroleum and natural gas produced in twenty-two states derives 42% of all values from Oklahoma and Texas, and 25% from California and West Virginia, or more than two-thirds from four states. Nine-tenths of our iron ore comes from the Lake Superior ranges of Minnesota, Michigan and Wisconsin. Nearly all of our copper, with the exception of one area in Tennessee, is mined west of Chicago and most of it west of Denver; furthermore, half of it originates in Arizona and a fifth in Michigan. Almost half of the lead and zinc mined in the United States is taken from the ground in Oklahoma and Missouri. The only gold mined in the east is a tiny amount in Georgia, while the major output is from limited localities in the Rockies, Cascades, and Sierras of the far west. The mining of phosphate rock is practically confined to small areas in Florida and Tennessee. The least localized

² Delaware, Nebraska, New Hampshire, Rhode Island, South Carolina.

³ Anthracite, bituminous, limestone, sandstone, clay, trap rock, slate.

industries are stone quarrying and clay mining; but one of the building stones, limestone, is centralized in Indiana and another, monumental marble, is distinctly a Vermont product.

Unlike a similar localization of manufacturing industries which are concentrated for economic reasons, the localization of mining is uneconomic and is due almost exclusively to the whimsical operation of geologic factors that produced minerals in particular places. However, in zinc mining fuel is such an item in smelter costs that smelters are clustered near natural gas. The marked disparity in the distribution of mineral deposits, even in minerals of the same kind, creates a wide divergence in the cost of mining in different places. The location of the mine in respect to settled communities and markets and such internal factors as size or position of ore bodies, relation to enclosing rocks, water, and depth, all vary astonishingly and influence costs just as amazingly.

3. Scale of Operations.—Mining affords examples of every scale of operation from the smallest one-man enterprise to the largest corporate undertaking. Moreover, small enterprises are numerous in all kinds of mining; indeed, three-fourths of all mine operators employ less than twenty men each. Yet, each kind of mining has a characteristic size. Copper, anthracite, and iron mining usually have been large-scale enterprises. Eleven big copper companies employ more than half of all the copper miners, while 22 large anthracite companies employ almost three-fourths of all anthracite miners and 65 collieries produce nine-tenths of the total values of anthracite. About 40% of the small anthracite operations are dredge or culm washery enterprises, whose total product was less than 3% of all anthracite. Iron mining, too, is usually a large-scale business. Six large iron mining companies in the Lake Superior district accounted for almost half of all iron ore produced in 1919. On the contrary, bituminous coal mining and petroleum well operations are more often conducted on a small scale and this is true also of sulphur mining, while stone quarrying often and clay mining almost exclusively are operated on the smallest scale. The lead and zinc industry shows both extremes, for, whereas most of the mines are small, four

large companies employ almost exactly a fourth of all wage earners in extracting these metals.

The large mining operations are noteworthy for their by-products. In addition to by-products of their own principal output they perform many lucrative services for other mines and nearby communities. These features are most usual in the petroleum, bituminous coal and gold and silver lode mines. Gold, silver, lead and zinc often are so intimately associated with each other in ores that frequently market price determines which is the main product and which the by-product. Ten per cent of our gold is a by-product of copper or lead, while 70% of our silver is derived from ores mined mainly for copper, lead, zinc or gold. Lead and zinc are almost always found in the same ores, price or content determining which is paramount.

4. Land Tenure.—Before the copper boom in the Lake Superior region in 1844, the national government refused to sell mineral lands but sought to collect rent in kind from exploiters of minerals on public lands. This boom intensified evils that had been in the system, namely, chicanery in making returns and difficulties in detecting false returns. So, in 1847 Congress legalized the sale of mineral lands in the public domain. Thus it was possible for mining companies to buy outright land known or supposed to contain minerals. Later, both in private property and public land, surface rights were separated from mining rights, a distinction which favored the mine operators' leasing instead of owning the areas they exploited.

Operation under leases is more common in mining than is the outright ownership by mining companies of the land they use. Yet the various mining industries vary considerably in this matter. Leasing is most usual in the quarrying of stone and the oil or gas well business, while it is rarely resorted to in the cases of mining copper or phosphate rock. While leasing is common in the coal industry only 30% of the total of active coal mining property is held under lease.

Many companies combine outright ownership with leases, and much non-mineral land is held under both tenures by mining operators. Some timber land so controlled is held for the pur-

pose of furnishing the mines with needed props or fuel but most of the non-mineral land is part of areas carried for ore reserves.

Besides the property of individual mine operators there is a relatively small amount of mining done by governments in public land although some of the government mining is prosecuted on leased land. The federal government, states, counties and municipalities, all are engaged in mining. A small part of this is in connection with penal institutions, the convicts being the laborers. But most of the government operations are related to highway or harbor construction and public utility services such as city gas.

5. Capital.—Investment in mining property and equipment is high in proportion to the value of the product and in respect to the number of persons engaged. This condition is brought about by the fact that mines are often in remote places and so compel companies to provide the facilities of a town. Moreover, the development of mines—shafts, gangways, ventilation, pumping and hoists—is costly. Then, too, in many types of mining, machinery plays an important part both in the actual mining and in the preparation of the gathered ores for market. That machinery is effective in mining is indicated by the experience in soft coal mines where the enterprises using machines turn out four and one-half times as much coal per mine as those that operate without machines. In large-scale iron mining with the help of machines the output in 1919 was 1,800 tons per wage-earner, while small enterprises without machinery produced only 350 tons per wage-earner. To illustrate how heavy the capital investment is in mining it may be remarked that whereas for manufacturing the investment is about 4,500 dollars per person engaged, in mining the corresponding figure is 7,000 dollars.⁴

Furthermore, minerals are ephemeral, the faster they are exploited the sooner gone, and they are irreplaceable by man's efforts. In order to guarantee the future of his business, the operator must buy or control reserves of ore, thus increasing his capital investment and adding to fixed charges in the way of interest, taxes, and wages of caretakers. These costs are included

⁴ This corresponds closely to the investment in farm land, tools, equipment and live-stock per person engaged in farming.

in the costs of ore actually mined and passed on to the consumer in higher present prices.

Since the assets of a mine are constantly reduced, dividends from mining must be higher than from investments in other enterprises; for mine dividends include not only interest and profit but also a portion of the principal itself. This is true regardless of the risk in mining and the excessive capitalization per person engaged. Hence, mine dividends cannot be measured in terms customary in other forms of business.

Relation of Mining to Commerce.—The localization of minerals and mining and a different localization of markets give rise to a goodly proportion of our domestic commerce. About 60% of our railroad freight tonnage consists of unmanufactured mineral products. Of this amount, coal and coke comprise about 40%, bituminous coal being the largest single item of railroad freight. The enormous tonnage of iron ore going east and coal going west on the Great Lakes is manifest to every American traveller, while coal and stone make up much of the cargoes of our river and coastwise shipping. Copper, nearly all of which originates west of Chicago and most of it west of Denver is used by 24 big consumers, all but two of which are located east or south of the Hudson. Zinc, with one eastern producer, is marketed almost exclusively in the east. So the story goes; hardly any minerals are used near the point of production except clay or stone; hence, minerals enter largely into domestic commerce.

As for foreign commerce, about a third of the value of our exports and much more than a third of the tonnage of our exports are mineral. While most of this is petroleum and its by-products, coal, iron, copper, zinc and lead enter into foreign commerce to an appreciable degree.

Relation of Mining to Manufacturing.—Mining and manufacturing are so intertwined that it is impossible to draw a reasonable distinction between them. There is much manufacturing in mining itself, due to the fact that except for a little gold, platinum and copper, minerals are rarely ready for use when lifted from the ground. Ores must be crushed, cleaned by wash-

ing or screening, graded and sorted to size, separated from associated worthless material, concentrated, burned, calcinated, roasted, ground, cut or polished, all of which may be classified as manufacturing operations.

On the other hand, many manufacturing businesses have preliminary mining as one of their features. This is true of most of the manufacturers of clay, lime, salt and portland cement.

Disregarding these technical distinctions, mines as a whole contribute much raw material to manufacturing, either for the product itself or as fuel with which to operate power machinery. Thus, coal may supply the raw material for companies producing coal by-products or it may be the fuel for a host of different kinds of manufacturing. Likewise, petroleum may be refinery raw material, boiler house fuel, or the source of lubricants to keep machinery in motion. Iron ore goes first to iron and steel mills and, after being refined there, becomes the raw material for structural manufacturers and builders, automotive works, the makers of equipment for the transportation or distribution of oil, gas or water, the producers of containers for food, the builders of agricultural implements or machinery and all the machine shops of the land where machinery or tools are made. In addition, iron enters into the manufacturer of paint, chemicals, glass, pottery and jewelry, and the ore may be used as a flux in smelting other ores. Even so humble a mining product as gypsum is important to manufacturers. It is made into plaster of Paris, wall plaster, stucco, plaster board and wall board, tiles, portland cement, and a soil "sweetener" for farmers. So with all the other mining industries, their product more or less manufactured provides the raw material for further manufacturing, whether it be farm fertilizers, automobile tires and batteries, telephones or a bronze statuette for the library table.

CHAPTER III

POWER

Primitive Power.—When Adam was ejected from Eden he was ordered to earn his bread by the sweat of his brow. Translated into engineering terms, the first source of power was man's own muscle. Not only for unknown centuries but even in this mechanical age human muscle has been a vital element in the production of food, shelter, clothing and luxuries. Modern mining and lumbering depend largely upon muscle, and, more than most people suspect, so does many a factory operation.

Very early in human history men learned to supplement muscle with simple hand tools. In the field of power perhaps the first aid to muscle was the lever. This was followed by the inclined plane and roller. Houses and freight cars sometimes are moved today by no greater power facilities than these. When man in the remote past invented the windlass and treadmill he made a great stride in multiplying his relatively feeble muscular power, and the most modern engineer uses the principles of these machines for lifting great weights. Many elevators are power windlasses.

Observing that the muscles of brutes were superior to man's, our ancient ancestors domesticated certain animals and applied their power to enlargements of the tools man had used. Discovering the power possibilities of a moving wheel arranged as a flywheel with straps or ropes, man again strode forward in his conquest of nature. To keep the wheel in motion both men and animals were employed. Some of our first American factories had no more complicated power plants than this.

Turning to the forces of nature, man tamed the wind to his bidding both to move ships and to turn wheels whose power was used to grind grain, saw wood, forge metals, and operate pumps. But wind being variable, man turned to the power that lies in the current or weight of falling water, inventing float or overshot

water wheels to do the work of wind mills. Yet wind mills still are familiar sights.

All of this heritage of power was brought to America by the colonists, and it was with this endowment that they dared the conquest of the wilderness.

Animal Power.—The chief power resource of American pioneers beyond their own backs, arms or legs, was animal power. It was furnished by oxen, cows, mules, goats and dogs. The utilization of these aids represented the principal superiority of the whites over the best of the Indians, for these had no domestic animals save dogs. The latter, however, were kept not alone for pets but for work. The white man's animals plowed the soil, cultivated the crops, threshed the grain, and hauled the harvest. Moreover, they were the transporters of logs, and carried or drew to and from the farms whatever passed between village and homestead, including the humans.

Nor have animals been released from this work on our farms, forests or mines. If the animal power on our present farms were converted into engineering units of "horse power" it would be found that the power equipment of this kind in American agriculture about equals the primary horsepower of all the prime movers in factories; the number of draft animals on farms exceeds 25 million, whereas the total horsepower developed on the premises of factories is about 20 million.

Water Power.—But if American civilization had depended solely upon human or animal power, our living would have been meager and our nation would have had scant prestige. Our first great supplementary power was derived from water.

The first great essential for the development of water power is an adequate precipitation either in the form of rain or snow. The mere recital of inches of rainfall per year is inconclusive because heavy downpours at infrequent intervals are less advantageous than drizzles regularly received. Due to evaporation, rains by day are not so valuable as showers by night. Then, too, the slope of the country, together with the soil and covering of the slope, modifies the usefulness of precipitation for power uses.

Storage in swamps or lakes contributes to evenness of stream flow and hence to economic utilization of the waterway for power. Since a long river has its flow equalized by the weather of the regions through which it finds its way, the greater the mileage of the stream and the wider the area of its drainage basin, the more likely it is to be valuable for power. Slope, however, modifies mileage. With a limitation on power transmission the nearness of a stream to human habitation influences its economic utilization.

The northeastern part of the United States, that is New England and New York, has most fully met the requirements for the development of water power, and it is there that water had been most important as a power producer at all times in American history. The Blackstone and Deerfield Rivers in Massachusetts have more of their potential power actually developed than any other water courses in the United States, and New England as a whole has developed 86% of its potential water power. The states that border the southern Appalachians possess considerable actual and potential water power. But the streams there are irregular, short, shallow and without adequate storage. The manufacturing industries that have made the most constant use of water power are pulp and paper mills, textile factories, flour, grist, and wood-working mills.

The region of greatest potential water power is in the far northwest, in the states of Washington and Oregon. About 80% of the undeveloped water power resources of the United States are in that area.

Water Wheels.—Of the three sources of power in water—weight, speed or pressure—it was weight that was first put to the service of man. A relatively large volume of water falling through a short distance upon the vanes or buckets of an over-shot or breast water wheel was long the familiar type of water power. This kind of water power could be exploited on small streams with imperfect dams.

But it had serious handicaps. The power potentiality of the wheels was limited, the largest ever constructed being the one at the Burden Iron Works of Troy, New York, 60 feet in

diameter, with a 500 horsepower capacity. Furthermore, the old-fashioned wheels were slow—the Burden wheel made two revolutions per minute—and were subject also to frequent interruptions of service due to freezing, floods and the pernicious activities of muskrats or eels. Imperfect dams built of wood which rotted, loose stones held with lime mortar which dissolved, or compacted earth which washed out, added to the difficulties of early water power engineers. Yet, since the power was clean, the mechanism easy to understand and simple to operate, as long as power demands were not excessive the old slow turning wheels were popular. The town-mill built in 1690 by Governor John Winthrop at New London, Connecticut, is still in use and so, too, are scores of other installations of honorable age.

Tidal Mills.—In low regions along the coast where streams had insufficient height for water power our forefathers sometimes utilized the difference in the height of tidal basins or streams at high and low tide. The water was impounded at high tide and released at low tide, with the effect of a waterfall. The Perkins Tide Mill built in 1749 at Kennebunk, Maine, has been in active operation, grinding corn continuously since it was erected. In 1927 a Perkins still owned and ran it, although not one related to the original builder. The fact, however, that the time of tides changes every day and that the period of usefulness is measured by a limited number of minutes or hours, has hitherto made tidal power of slight importance. A modern gigantic proposal for a tidal power development on a scale sufficient to remove these obstacles to efficiency was made in 1926, when the legislature of Maine granted permission to utilize the tidal power in Passamaquoddy Bay.

Water Turbines.—Realizing the restrictions of power derived from water by utilizing its weight alone, our ancestors early turned to devices that would develop power from water through its speed or “kick.” In 1804 Benjamin Tyler of Lebanon, New Hampshire, patented a “Wry Wheel,” which was probably the earliest water turbine. New England textile manufacturers, feeling the pinch of the limited power inherent in the old-fashioned

water wheels, encouraged their hydraulic engineers to perfect the turbine. Uriah A. Boyden, Samuel B. Howd, James B. Francis, Asa M. Swain and James Leffel were among the distinguished American engineers who perfected the water turbine which found its first and largest market in the New England cotton and paper mills.

The water turbine ran at high speed, developed increasingly large amounts of power, took up little space and, being housed indoors, was freed from most of the vagaries of weather. Since the Civil War all new water power projects have depended upon turbines and most of the older enterprises formerly using weight wheels have dismantled them in favor of turbines. All modern hydraulic power is developed by turbines or other high speed water machines.

Impulse Wheel.—Another type of water wheel differing essentially from the old fashioned impact wheel as well as from the turbine is called the "impulse wheel." This, having vanes or cups on its circumference, is motivated by a jet of water under high pressure directed against the cups. Impulse wheels generally run at high speeds and are adapted to sites where the water drops from considerable height. In Europe the impulse wheel is credited to Jean Victor Poncelet, in America to Lester A. Pelton, who developed it in connection with hydraulic mining in California. Although all the early Pelton wheels were small, large ones have been developed as the result of constant experiment. Both large and small Pelton wheels generally have been used for producing electricity, but for this work have never been as popular as turbines.

Water versus Steam.—During most of the 19th century water power fought a losing battle against steam. The invention and development of the turbine was part of this campaign, representing water power's struggle to hold its place. The heavy initial investment in water power, its limited flexibility and its requirement that mills be located alongside the stream, often in thinly populated areas, all told heavily against water power. Its cheapness per unit of developed power was outweighed by the convenience of steam power.

In the closing years of the 19th century the situation changed. By the use of concrete for dams and retaining walls for storage basins, the largest rivers were brought within the scope of hydraulic engineering. Even more important was the direct coupling of high-speed water turbines with electric dynamos. Then the rapid extension of the distance over which electricity could be transmitted made remote power production feasible. Since all this belongs to the story of electricity, we merely mention it as explaining the recent rapid strides in water power development. As a result of the change steam power, especially individual units in factories, is now on the defensive.

Steam Power.—That power resides in steam is no new knowledge of the modern world. As long ago as the first century A.D., an Alexandrian named Hero invented mechanical toys operated by steam power. But it was not until the 17th century that Italian, British and French experimenters began to show the practical application of steam power. In 1705 Thomas Newcomen invented a steam engine which six years later was put to work pumping water from a mine, an event that may be said to have started a series of experiments with steam engines, culminating with the destiny-shaping engine of James Watt in the middle of the 18th century.

Watt's first great contribution was his invention of the separate condenser. He saw that the chief faults with the Newcomen engine were its slow motion and excessive waste of steam. In order that the cylinder should always "be as hot as the steam that exerted it" Watt closed the cylinder and provided a separate condensing vessel into which the steam led after it raised the piston. He installed an air-tight jacket to maintain the heat of the cylinder and added a light packing in the cylinder head for the piston rod to move through, together with a steam-tight stuffing box on top of the cylinder. Then he alternated the admission and condensation of steam upon both sides of the piston, doubling the number of power strokes and increasing the speed of the engine. Watt next devised a crank for changing the reciprocating motion of the piston rod into a rotary motion. All

of these are essential features of modern reciprocating steam engines.

Watt also introduced the term "horsepower" for rating the capacity of his engines. By experiment he discovered that a heavy draft horse could lift 550 pounds one foot in one second. The power of the horse in Watt's experiment was equal to that of eight stalwart men. It is now assumed that one mechanical horsepower equals that of ten men, although some authorities say twenty men. One "horsepower" is that amount of energy capable of lifting 550 pounds one foot in one second, but may be expressed in other pounds, distances and times in the same ratios.

Improvements.—Although Watt established the fundamentals, a long line of distinguished engineers has developed the steam engine so as to extract every possible bit of the expansive power of steam. The steam engine really transforms heat energy into work. So great are the losses in the burning of coal, expanding of steam and from friction, that the very best modern steam engine delivers in work only about 15% of the potential energy stored in the fuel. Hence from Watt onward constant intensive research has been applied to improve the technical efficiency of steam power. The earlier engineers devoted their attention to the engine itself, first along the line of multiple expansion, then toward a refinement of valves and other working parts. Later efforts were directed to the furnace boiler, and even the water. The shape and arrangement of fire box and flues, the handling of fuel and residues, the material construction and design of the boilers, preheating water and superheating steam after it leaves the boiler, the filtration, precipitation and chemical content of the water, all these have been given close study with remarkable results.

Steam Turbines.—Despite the intellectual effort poured into the reciprocating steam engine, it fell far short of an ideal mechanism. Consequently, in the eighties a few men abandoned the piston type of engine and sought better returns from a utilization of the speed or kick of steam as it issues from an opening, applying to steam something of the principles of the hydraulic

turbine and impulse wheels. Gustav de Laval, Sir Charles A. Parsons and the American, G. C. Curtis, were the pioneers with steam turbines. Their efforts supplemented by the ideas of many other men, quickly brought the turbine to a high state of perfection. For the steam turbine advantages were claimed in steam economy, freedom from vibration, lack of friction, small floor space, and low foundation costs. These features made it popular, not only in marine engineering and central electric power stations, but also in the power plants of factories. Frequently both turbines and piston engines were used in the same room, the turbine running on the steam exhausted from the reciprocating engine. In a few instances, turbines not only operated with steam but a combination of steam with vaporized mercury; there was such an installation at the Hartford Light and Power Company in Connecticut. Since turbines have a rotary motion they are admirably adapted to direct connection with dynamos. The typical modern steam power house utilizes fuel *blown* under a boiler, creates steam that is used several times in several different ways in connection with reciprocating and turbine engines, and distributes the power by means of electricity.

Use of Steam Power.—Colonel John Schuyler, operator of the copper mine given his name near Newark, New Jersey, imported in 1753 a Watt steam engine to pump water from his mine. This, the first steam engine in America, had few companions in the United States until after 1800. There was little mining and less factory production here at that time. Even after the industrial regime really started in 1814 it was more than thirty years before coal-fired steam engines seriously threatened the supremacy of water-turned wheels. It was not comparative costs—for water power costs were then about one-fourth the cost of steam—that made manufacturers turn to steam about 1850, but ease of expansion and freedom in location of factories. Used first to carry the overload of water driven mills, steam engines soon became the main reliance even of plants located at water power sites. For city factories away from water power, steam was the sole source of power.

From 1850 to 1900 the expansion of manufacturing, mining,

and even lumbering depended more and more exclusively upon steam power. In 1870, when the census began to collect data of the horsepower installed in manufacturing, steam accounted for 52%. In 1900 the share was 82% for steam. By 1923, however, steam had shrunk to 48% of the total.

Labor never has been cheap in the United States, and hence our industries always have been receptive to machinery. Since the World War, the conditions left by that conflict together with the restriction of immigration have left wages at a new high money level, so that industrial executives have racked their brains to offset labor costs by increased use of mechanical devices. Nearly all the improvements have comprised expensive attachments and refinements, such as the substitution of motor drives in the place of belts, the inclusion of ball and roller bearings, and flood lubrication by pump or splash. Control handles within easy safe reach of the operator, and mechanical rather than manual movement of materials to, on, and away from machines are part of this new mechanization. There has been a marked tendency, also, to install specialized machines for mass manipulation of material, such as multi-spindle drillers, or multi-head millers. Although some of the advances economize power—e.g., roller bearings—the total effect of all the new enthusiasm for the “iron man” has been to increase the demands for power. Since 1909 the horsepower per worker in manufacturing has advanced by over 50%; that is, in 1927 it was more than one and one-half times what it was less than twenty years ago. Looking at the matter differently, we may cite the United States Department of Labor as authority that between 1914 and 1926 productivity per worker increased 59%, taking all industries together. In the manufacture of tires productivity advanced 211%, which was the maximum, while in the boot and shoe industry the minimum was touched with but 6%.

This productivity, largely the result of advances in power driven machinery, made possible a period when wages rose while prices fell, the longest era of prosperity in American history.

Fuel.—Anything that will burn may be used as fuel for a steam engine and an amazing variety of fuels have been so

employed. Practically, the fuels have been limited to wood, coal and petroleum products.

In lumbering operations, in some mining and in the power houses of wood using factories, wood has been the sole, principal or subsidiary fuel for raising steam. In the aggregate, and compared to other industrial fuels, wood has been of minor importance.

Of all the fuels, coal has been by a very wide margin the most important. In the United States anthracite was the first leading industrial fuel. This was due to the location of the anthracite fields in eastern Pennsylvania, almost at the center of the manufacturing area of the eastern United States and with a command of water transportation. Despite its limited area and constantly increasing price due to natural advances in the cost of mining deeper, thinner or more contorted veins, plus artificial boosts by monopoly control, anthracite held its supremacy as an industrial fuel until 1869. From that date its use in manufacturing plants declined, until a prolonged strike at the opening of the 20th century caused manufacturers generally to change their grates and shift to bituminous coal.

In 1923 more than seventeen times as much bituminous coal was consumed for power as anthracite, whereas the total bituminous mined is only five times as much as anthracite. In Pennsylvania, New York and New Jersey near the anthracite mines and on the main anthracite shipping routes, one finds the most of the plants that still use anthracite as a power fuel. A goodly proportion of this anthracite is not the domestic sizes but pieces of very small size, whose price is set by competition with bituminous. To the anthracite mine operators the sale of these small sizes, amounting in volume to 35% of the total output, represents the disposal of a by-product; it is the 65% in domestic sizes that bear the burdens of cost. Hence, it is more in name than in fact that anthracite still is used for industrial power.

The bituminous coal of the United States, underlying an area of 500,000 square miles scattered over thirty states, constitutes the greatest coal resource of the world. Varying in quality from the prized steam coals of West Virginia to the scorned lignites of Texas and Dakota, our soft coal seams, taken as a

whole, afford practically unlimited supplies of fuel sufficient for any feasible expansion of steam power within our boundaries. Our normal yearly production of bituminous coal is 500 million tons, and roughly $66\frac{2}{3}\%$ of this is used for power by railroads, ships, mines and factories.

Most of our power plants burn "raw" bituminous coal just as it comes from the mines, but a few, for efficiency or economy, pulverize it before blowing it into the fire box. In some instances, the raw coal is first coked and coke then becomes the fuel. If the coke is made in by-product plants, either the coke or the gas by-product may be used as a steam fuel. Distilled coal yields many of the things derived from petroleum and when these products are removed the residuum is a better fuel than the original material from the miner's pick. About 1,000 useful products are obtainable from distilled coal. For every four dollars worth of coal charged into by-product ovens in Pennsylvania in 1925, six dollars worth of by-products was derived.

Crude petroleum is another important steam fuel. It was first used on locomotives in mountain regions and later in ships because of its ease of handling. But it has a wide employment in factories and city lighting and power stations. Many factories whose main power house is operated with coal fuel nevertheless use crude oil for certain processes; some merely for heat, others for power. Many of the distilled products of petroleum also are steam fuels. However, since most of these distillates can be used in internal combustion engines, their employment for steam is wasteful and so is relatively rare.

Natural gas, so closely associated with petroleum, is an ideal fuel. Consequently, wherever it is available it is a mighty mainstay of power houses. Manufacturers whose fuel is a large item in the cost of production tend to cluster around natural gas fields. This is true of the makers of glass and the smelters of zinc and, to some extent, the manufacturers of portland cement.

Internal Combustion Engines.—Although a successful internal explosion engine was unknown until the comparatively recent inventions of Lenoir, Otto and Langen, men have dabbled with the idea for a long time. Among the first attempts was that

of Hautefeuille in 1678, who used the gas generated by the explosion of gunpowder to expel air in a chamber, whereupon the condensation of gases produced a vacuum in the chamber. Huyghens, in 1680, devised a cylinder in which, after the vacuum was formed, atmospheric pressure pushed downward a piston at the top of the cylinder.

The first real gas engine appeared in 1791, when an Englishman named Barber invented an engine in which a stream of carbureted hydrogen gas was introduced by one induction port and atmospheric air at another; these two meeting and exploding produced a force to move a piston. In 1799 Lebon, a Frenchman, proposed that an electric spark be the igniter of a mixture of air and gas in a cylinder.

After Lebon, various men of different nationalities experimented with gas engines. But the modern gas engine may be said to date from 1860, when Lenoir put a crude but practicable gas engine upon the market in France and the United States. The first cost of a Lenoir engine was high and it had to be watched lest it overheat, but its operation was cheaper than a steam engine for small horsepower and, consequently, it became popular both in the United States and in France.

The combined talents of N. A. Otto and Eugen Langen produced an engine worthy of exhibit at the World's Fair at Paris in 1867. Crude and noisy, this model was the most economical with gas and the exhibit led to orders of some 5000 of these machines ranging in power from one-third to three horsepower. Spurred by this success, the two inventors sought to improve their product, eventually in 1876 hitting upon the four-cycle engine, as it is now known. This engine cut the cost of gas engine operation in half and paved the way for the marvelous development of gas engines in recent years.

Although the noted use of internal combustion engines is for automobiles and airplanes, they have had a worthy appreciation for industrial power. The early gas engines were all small and proved a boon to enterprises whose power requirements were inconsiderable. Compared to steam engines, these gas engines required little fuel storage space, had no problem of ash disposal and withal were cheap to install and operate. Kerosene or gaso-

line, each of various grades, were the fuels used in these power plants.

For large internal combustion engines we had to await the work of Rudolf Diesel, who introduced his engine to the world in 1897. This machine differs from all other explosive power producers by gaining a combustion temperature through the compression of pure air. The fuel is introduced gradually into the compressed air and burned with little or no increase in temperature during combustion. The motor, although operating upon a four-cycle principle, differs in considerable detail from the Otto type. The Diesel engine runs as smoothly as steam, costs no more to install, is less expensive to operate and may employ a great variety of low grade fuels. Nearly all the fuels used with these engines have been liquids, even the thick heavy tar oil, but recently efforts have reverted to Diesel's original plan to utilize powdered coal. The United States Department of Agriculture ran a Diesel engine in 1926 experimentally on grain dust.

Although the Diesel engine for a long time was confined to small sizes—that is, a few hundred horsepower—of recent years the size has been magnified until engines of nine cylinders capable of producing 15,000 horsepower have been reached. As the capacities of Diesels advanced they came into widespread use. The marine Diesels threaten to oust steam engines from ships. In railroad engineering the Diesel engine, because of its absence of smoke and noise, its economy in fuel and its low cost compared with electrification, is coming into favor particularly for terminals in areas of congested population. Manufacturing industries have taken the Diesel engine into serious consideration when deciding power plant changes.

The way in which gas engines have increased in size is indicated by the figures for 1914 and 1923. In the former year there were 37,000 internal combustion engines in industry, a number which shrank to 15,000 in 1923. In the latter year, however, with less than half the *number* of engines, the horsepower produced was 25% greater than in 1914. That is, the normal installation of 1923 was two and one-half times as powerful as that of 1914.

That fuel has some influence on the installation of internal combustion engines is evidenced by the fact that both the greatest number of engines and greatest power output are in factories or mines in the Middle Atlantic and east north Central States. In order of horsepower derived from gas engines, the states rank with Pennsylvania first, Indiana second, Ohio third and New York fourth. Outside of the districts in which the above states lie no other state approaches these in total horsepower from internal combustion engines except Texas, which is an oil state.

Electric Power.—Some six hundred years before the beginning of the Christian era the Greeks knew that when certain substances such as jet or amber were rubbed they had an attractive influence upon fragments of straw, feathers or leaves, and the memory of these ancient observations lingers in the word electricity, which is derived from the Greek *electron*, meaning amber. About 1600 A.D., William Gilbert, royal physician in England, undertook a series of researches into magnetism that opened the way to the "age of electricity." Like all advances in science, the story of electricity involves the experiments, discoveries and inventions of many men at different times in diverse nations.

To the advance of electrical research, colonial America, in the person of Benjamin Franklin, made a significant and even spectacular contribution. Later, the work of Joseph Henry and still later, that of Thomas A. Edison, placed America abreast of the world in electrical knowledge. Through the early 19th century America was tardy in the experimentation with and utilization of electricity, but once our cultural and industrial growth reached the point when great experimental laboratories were built, our contributions to electrical science came with a rush and our use of electricity passed beyond that of any other nation.

Electricity was made to serve man; first, to carry his messages and, then, to illuminate his home or office. The former involved slight power while the latter was small scale and local in its application. With the opening of the 20th century men seriously considered electricity as a source of industrial power.

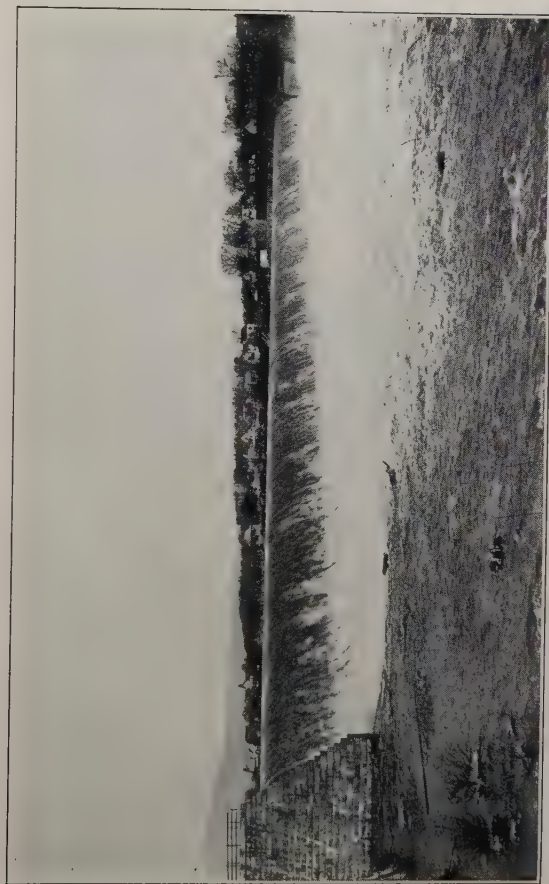
Inasmuch as electricity does not occur in nature in a form useful to man, it is necessary to produce it secondarily by the aid

of some primary power machine, that is, by waterwheels, steam engines or internal combustion engines. Yet, once produced, electricity is superior to other power in that it is virtually energy itself freed from all the limitations of substantial form. To this extent it resembles sunlight. As virtual energy, electricity is too mysterious to discuss outside a laboratory, so that we can tell only how it is made, the choices between methods of creating it and the extent of its use.

Individual Production.—The earliest incursion of electricity in industrial plants was for lighting. For this purpose a small dynamo was added to the power house equipment. The dynamo was so incidental that it exercised no influence over the choice of primary power, that is, water turbines or steam engines. Slowly, first for one factory process, then for another, separate motors appeared about the works, multiplying until the old lighting dynamo proved insufficient for the power load.

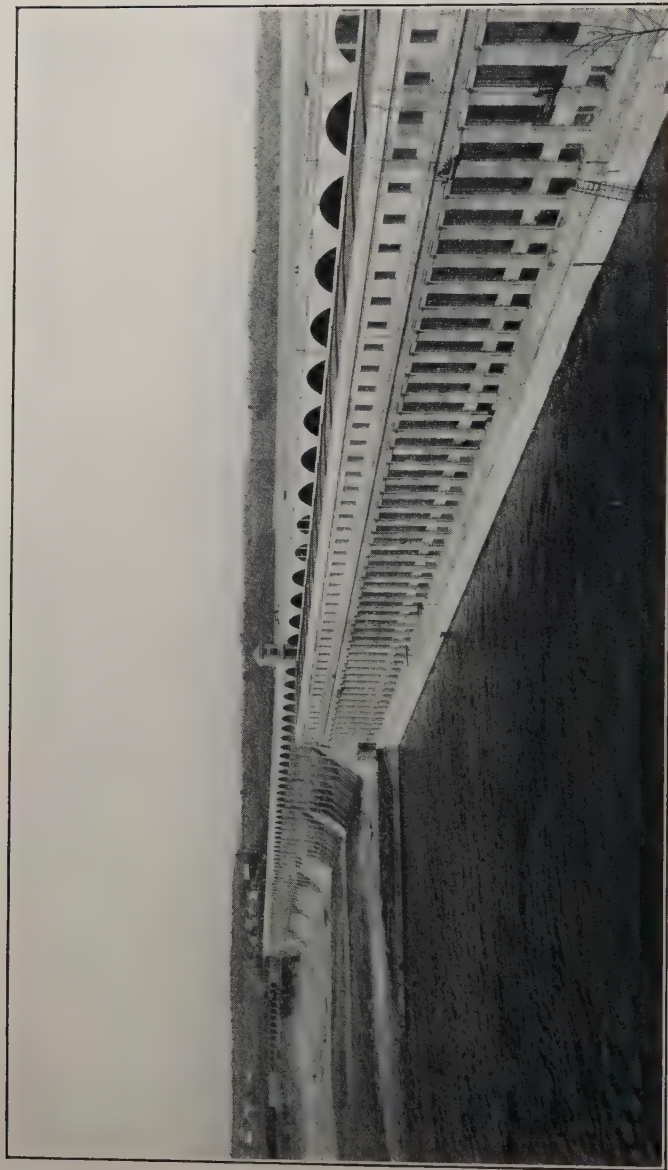
By that time, some of the advantages of electricity in the transmission of power began to appear. It was clean, scattering no dust nor oil. It was practically noiseless. It left the upper part of a work room free from belts or shafts, which not only had a good psychological reaction on workers and managers but admitted more light and clean air to the work-place. With individual motors installed, managers learned that they could arrange machines in the most efficient manner, no longer tied to the straight parallel lines of shafts and belts. Furthermore, a better routing of material could be secured since shops were no longer necessarily bunched according to their power requirements. With motors, too, speeds were easily adjustable, power measurable, and expansion of separate units practicable. Next, it was found that there was often an economy in power used since the loss from friction in belts and shafts (from 25% to 60%) was removed and because the stoppage of a machine also halted the flow of power. On the other hand, one machine or floor could be kept busy without putting the whole power equipment of the plant in motion.

As these advantages in electrical transmission materialized in reports to the chief executive, his thoughts were concentrated on



(Courtesy Boston and Maine Railroad.)

PLATE 3. The Dam on the Connecticut River at Holyoke, Mass. First large-scale water power project in the United States.



(Courtesy Office of Chief of Engineers, U. S. Army.)

PLATE 4. The Wilson Dam on the Tennessee River at Muscle Shoals. The latest large-scale water power project in the United States.

the power house. The dynamo was no longer an incidental machine but the heart of the power problem.

Meanwhile, outside the industrial field changes were taking place in the field of public utilities. The first central lighting station was opened in 1882 on Pearl Street, New York City, furnishing the current for a few hundred 16 candlepower lights in nearby buildings. Following this leadership through the Eighties and early Nineties many cities, towns, and hamlets had their own little electric light plants run only in the hours of darkness and sometimes on a "moonlight schedule"—on moonlight nights there were no electric street lights. The lighting plants were accompanied by installations of electric street railways, the first being at Ansonia, Connecticut. To reduce costs by balancing uses, lighting and street car companies frequently combined. Then, in order to offset competition and reduce costs by combining services, gas and electric companies coalesced. These things happened in individual communities. The next step was to centralize power houses serving several communities and different public utilities, discarding the old, small, separate plants or else using them as substations. When the centralized electrical plant appeared it began to bid with industrial enterprises for the current uses developed in their mills.

Making Power or Buying It.—This point was reached just as the chief executive was focusing his mind on his own power house and considering the problem of dynamo operation. He now had the alternative of making his own power, as was the custom, or of buying electric current from a central station.

In favor of retaining factory power plants was the fact that, if they had boilers and steam engines as the prime movers for dynamos, the waste steam was valuable for heating the works in all seasons except summer and even then on cold, rainy days. Moreover, many drying processes called for steam heat. If power was a principal item of cost in production then there was little question that it was economic to make it on the premises rather than purchase it. A very large industrial plant had within itself most of the features argued in favor of the economy of a central station.

Against this array of facts the central station pointed out to manufacturers that the latter equipped their factories for the maximum power demands but seldom used this equipment in full. Hence, much capital was idle and unproductive. It is true that in many shops, particularly machine shops, the power used is often as little as one-third of the power capacity. Even in textile mills, where the machinery is supposed to run continuously at high speed, the power used may be only 80% of the power capacity. In technical terms manufacturers equipped for the "peak load" regardless of their "load factor." The central station supplied and asked pay for only such amounts of power as were actually used; since their service was flexible they could care for any reasonable peak load upon demand. Moreover, with purchased power all the space and labor required for power house, line shafts, and belts, was saved, while fuel storage and handling with all its dirt and dust and anxious moments at threats of strike, was eliminated.

The central electrical power plant could make its offers at comparatively low rates because, due to the variations in the peak loads of its customers, its total equipment for their total needs was as much less than their combined total equipment as their load factors were less than their peak loads. Also, the central station possessed some of the advantages of large-scale production; it could locate at the most economic point in the district and supply equipment in the most economic sizes or grades. By combination it saved wages of employes, for the central station hired fewer workers than the combined former pay rolls of the power plants of its customers.

The central power stations had daily and seasonal peak loads of their own, particularly if they sold current for light as well as for power. These peaks came at the times when most of their industrial customers started work at morning and after lunch, and the highest peak occurred in winter between 4 and 7 P.M., when house and factory lights were switched into service. Since electricity cannot be stored like water or gas, it is produced most economically when it is used as steadily as it is manufactured. To attain this desired end the central stations not only got as many industrial power customers as possible, but urged the sale

of power household equipment, such as flat irons, stoves, heaters, vacuum cleaners, curling irons, cigar lighters, washing machines and refrigerators.

Rented Power.—The arguments in favor of buying instead of making power appealed to a great many industrial executives. Small plants, generally, and factories whose power was a small proportional item in costs, shifted to central station service. Since 1914 this movement has accelerated. For illustration, in 1914 there were some 400,000 electric motors driven by purchased current, while in 1923 the number was 1,400,000. The horsepower of the 1914 motors was 3.8 million, while the figure for 1923 was 13.3 million, indicating a tendency toward larger motors. Against these figures should be placed those of the number and horsepower of motors driven by current generated in the using establishment. In this category the number of motors between 1914 and 1923 increased from 300,000 to 600,000; that is, the number doubled while motors driven by rented power more than tripled. In horsepower the figures for motors driven by current produced on the premises were 4.9 million for 1914 and 8.2 million in 1923. Again, the increase in capacities of motors run by rented horsepower was superior. Since the state of Pennsylvania has more industrial power equipment than any other two states its experience is indicative of a trend. In 1900 only 10% of its industrial power was electrical. By 1915 the figure was 30% and in 1925 had reached 65%. Of the electric power installed in any one year, about 80% represented new construction, while 20% was a substitution of electricity for mechanical drive. It was estimated in 1927 that approximately 45% of the possible motor load was already connected. The great undeveloped markets for central stations are for industrial heating, domestic household power utilization and rural connections.

Central Station Prime Movers.—Granting the economy in many cases of central station electrical power, the question arises as to which of the prime movers the central station will install to operate its dynamos. The practical choice lies between hydro-electric plants and carbo-electric stations.

Hydroelectric stations appeal to the philosopher but not often to the business man. The philosopher sees in a hydroelectric plant the utilization of an otherwise wasted resource. He dwells upon the saved labor of thousands of miners and the national economy in the release of a goodly share of our railroad equipment and labor. He points out that water is a continuous resource, and once a site is developed its cost of operation is very low. On the other hand, the business man knows that most of the water power sites where hydroelectricity can be produced cheaply are either in use now or are rigidly reserved for the future. Of the less desirable sites he realizes and can prove in cold figures that the initial investment is excessive, resulting in heavy annual fixed charges. The philosopher looks upon the burning of raw coal capable of being distilled into a thousand useful commodities as an economic crime, for which every dollar's worth of raw coal consumed we throw away one and one-half dollars' worth of by-products which could be saved. Furthermore, the carriage cost of coal from a mine mouth to a power plant within fifteen miles is only two or three cents per ton mile, while the haulage per ton from mine to Atlantic coast—300 miles—is about three and one-half dollars. He foresees the breakdown of railroads if coal mining and use continues at the pace it has been moving; and he regards the unnecessary shipment of coal as an appalling waste of national industrial facilities. He emphasizes that the operating cost of a carbo-electric plant is very high.

On the other hand, the business man knows that raw coal is cheap and always available. He is aware that the first cost of a steam power plant is relatively small; that such a station can be easily expanded; and that there is a wealth of experience to draw upon in the design, construction and operation of such a plant. When asked to erect his carbo-electric plant at the mine instead of at the market in order to save the waste in railroad facilities in hauling coal needlessly, the business man readily proves that it is cheaper to pay freight bills to a railroad specialized in coal haulage than it is for the power magnate to build, maintain and operate power lines. He also asks the pertinent question as to the source of water to run condensers at the

mine mouth. He knows that 400 tons of water are necessary for every one ton of coal and that this amount of water near mines is either rare or irregular in supply.

Since it is the business men and not the philosophers who construct the electric stations, it is not surprising that of the total power generated in 1926 fuel burning power plants produced 65% and water power plants 35%.

Fuel and Water Resources Complementary.—Fortunately for the United States, those sections of the country that are poor in fuel are relatively rich in water power. New England and New York, the South Atlantic States, the Southwest and the Northern Pacific States, which together produce less than one-tenth of 1% of our coal, possess more than three-quarters of the potential water power. In these regions about 10% of the most readily available water power is already developed, but nowhere are the actual installations within distant hailing of the possible. A few hydroelectric plants are by-products of commercial canals or irrigation projects. New England solidly supports the Great Lakes-St. Lawrence Waterway because it means cheap electric power, while Los Angeles enjoys very low rates on electricity as a by-product derived from ventures in irrigation and city water.

While the water power regions fringe the country the central areas are solidly endowed with coal, petroleum and natural gas. Naturally, in this area carbo-electric power overshadows and well-nigh obscures water power.

This complementary distribution of water power and fuel means that no part of the nation is without a resource from which electricity in all needful quantities may be produced.

Super Power.—When the United States by 1910 was dotted with central electric stations, each with its own peak load and load factors, the proposal was advanced to tie these together, to do for each station what the station does for the industries it serves. By combining central stations the peak loads would be distributed and leveled and, moreover, each would be guaranteed against losses due to unavoidable shutdowns. Upon this basis the idea was extended to bring in new hydroelectric plants pro-

ducing at remote spots and not serving as central stations, as well as similar mine-mouth carbo-electric plants. Finally, it was conceived that transmission lines could net an area acting as common carriers for current produced at a great variety of sources. That is, large scale factories, smelters and the like with an excess of current, central stations, public utilities and remote producers all could feed current into a power line. From this line, current could be drawn at will by households, factories, mines, public utilities and railroads—at an agreed price. This idea was called “super power.”

Super power at first was thought of as applying to specific areas such as the region from Boston to Washington, east of the Appalachians, or the Pacific Coast. Almost at once it was realized that there would be several intensive super power zones scattered across the continent, and that the zones could be interconnected so as to constitute one Giant Power. The factors limiting the distance of electrical transmission have always been the handling of high voltages and losses of current in transit. The first high voltage line, carrying 11,000 volts, was constructed in California in 1893. Three years later this was followed by a 25,000 volt line. The subsequent story is as follows:

Date	Voltage	Transmission Distance
1900	60,000	50 miles
1908	110,000	100 "
1913	150,000	150 "
1923	220,000	200 +"

A laboratory experiment with a million volt current was made in 1926, and in 1927 Baum made his important announcement.

Between 1910 and 1927 the super-power idea was carried a long way toward accomplishment, and considerable progress was made in regard to Giant Power. One combination extends from Oklahoma to the Atlantic, another from the Canadian border to Mexico, while both of these are about to be tied with a third, centering in Colorado. The one great barrier to realization of Giant Power has been the limitation upon practicable electrical transmission to about 200 miles, although there were in existence longer lines than this, the greatest in 1927 being the 550

mile line from the Big Creek system of California. To be sure, hardly any settlement in the country is more than 200 miles from a potential hydro- or carbo-electric resource, but the idea of Giant Power in all its grandeur of continental scale was thwarted so long as electrical transmission was limited.

Early in 1927, Frank G. Baum—who had set forth a plan of continental power distribution in his “Atlas of the United States Power Industry”—sold to the General Electric Company an automatic regulating device which, in effect, converts a long power line into a series of short ones, each thoroughly stabilized and with a minimum power loss. It is claimed that this control will permit the transmission of electricity for unlimited distance. If that is true the day of Giant Power has dawned.

Just as the steam engine broke the tight confines of early water wheel factories and permitted the spread of industry, Giant Power would allow industry to scatter over the face of the continent; so far as the power factor is concerned, industries would be able to locate anywhere. We know that it was the localizing influence of old-fashioned water power that promoted the cluster arrangement of industry in New England. Although coal and steam liberated industry, still it was economic to locate within reasonable distance of coal mines. The only section that has been industrialized since electricity became important is the South Atlantic. There industry is not localized but is spread thinly over a great area. A balance between manufacturing and farming is not only economically desirable but socially advantageous. That electric power has this effect the South demonstrates. If Giant Power can disseminate manufacturing throughout the nation it will prove a blessing. Likewise, Giant Power would open the way for an agricultural revolution by bringing unlimited cheap power to every farm. What that would do for agriculture is utterly incalculable. We may now be standing on the verge of these two astounding developments.

But limiting ourselves to the progress we have made the record is awe inspiring. Since 1905 the capital invested in the electric power industry has grown from one billion dollars to 7 billion. In 1925 the total energy generated was about 61 billion kilowatt-hours. A kilowatt is a unit of electrical energy equiv-

alent to 1.34 horsepower of mechanical energy. Of all the nations of the world the United States produces and uses both in aggregate and per capita by far the most electric current. Some of our single largest installations have greater capacities than the total of some nations. One machine installed by the Brooklyn Edison Company cost a million dollars to build and install, and generates 80,000 kilowatts, the highest rating of any turbo-generator in operation. The New York Edison Company has one station generating about 700,000 kilowatts. Similar big carbo-electric installations are to be found in Philadelphia, Chicago, Cleveland, Detroit and Long Beach, California. Of the large hydroelectric plants Niagara comes to mind at once. The modern development there—the use of power at Niagara dates back to 1725—began in 1890. On the first ten turbines there were mounted generators of 5,000 horsepower; the latest ten generators are rated each at 40,000 horsepower. Notable enterprises have been erected at McCalls Ferry, Pennsylvania; Keokuk, Iowa; Muscle Shoals and Conowingo, all on rivers. Several of the irrigation, flood control, or city water supply projects of the southwest and Pacific Coast, such as the Roosevelt and Boulder Dams and Owens River, develop or are planned to produce large amounts of hydroelectricity. Modern canal plans, such as the St. Lawrence-Great Lakes Waterway, generally involve hydroelectric power as a by-product.

In 1927 electric service was supplied to every city of 5,000 or more inhabitants, to 75% of all communities above 1,000 people, 40% of all places above 250, and 20% of all hamlets of less than 250 persons. The per capita consumption of electricity was 371 kilowatt-hours in 1919 and 627 kilowatt-hours in 1927.

Compressed Air.—At one time roseate predictions were made for compressed air as a form of power. Experiment with it began around 1800 but it was not until 1861, when the Mont Cenis Tunnel was constructed, that compressed air for drilling proved its effectiveness. Five years later compressed air was used with conspicuous success in the boring of the Hoosac Tunnel. There were one or two attempts to compress air at central sta-

tions and pipe it like city gas or electricity to industrial customers. The failure of these has limited compressed air to production and use within the individual plant.

Compressed air has had three qualities to recommend it, its safety, portability in flexible hose, and its spreading force. The first two have led to its employment in underground mine haulage where electric sparks were dangerous, and in stone quarries, iron foundries, and on structural work. Air drills, hammers, reamers, and presses are familiar to nearly everyone. The third quality, since it covers large surfaces quickly, favors it for painting, sand blasting and sweeping streets.

Solar Heat.—The greatest source of energy, solar heat, has been practically ignored. From time to time attempts have been made to concentrate sunlight by means of mirrors and utilize the heat for man's work. None of these has met with pronounced success, although several have accomplished the results sought. The trouble most frequently encountered has been that the sun does not shine continuously; its face is hidden every night and on many a day by clouds. The places with the fewest clouds have been places of least population, so that power produced in such a region has had little or no market.

Internal Heat of Earth.—Another somewhat visionary source of power is the internal heat of the earth. This it has been proposed to tap by pipes leading downward from the surface, or at the ground level in places where hot springs, geysers, or volcanoes belched. At Volterra, Italy, Iceland, and in California these sources of power have been directed to benefit human beings but, obviously, with present knowledge, experience, distribution of population and competing sources of power, the utilization of earth heat is more interesting than important.

Waves.—Those who live by the sea or visit it know the tremendous force of waves. Folks with brooding minds have looked upon this wasted energy and wondered how it could be harnessed for the benefit of mankind. Some ingenious machines have been invented for this purpose but none has ever chained Neptune. Waves are not standardized and neither is weather.

No wave motor has ever overcome the constant variation in waves produced by the gales that lash them to tumultuous heights, followed by the breezes that merely ripple the surface of a gently heaving sea.

Status of the Power Industry.—Until the development of the electrical industry the production of power was subsidiary to the enterprises in which it was used. With the appearance of centralized electrical power stations, the commercial production and sale of power began. The later improvement in long-distance power transmission, together with the interlocking of electrical power stations, opened the way for the exploitation of power in the manner of a natural resource. At the present time, pioneers in this business—individuals, corporations, and groups of interested parties—are seeking control of this new resource just as in former generations, forests and minerals were concentrated in the hands of men of foresight. Inasmuch as the power industry is relatively young, it offers attractive opportunities for exploitation, but these opportunities are circumscribed because they are not open to small-scale operation.

CHAPTER IV

HOUSEHOLD MANUFACTURES AND CRAFTSMANSHIP

The Stages in Manufactures.—A one-room cabin, imperfectly chinked, solitary, but cluttered with children, was the ancestor of the throbbing, clattering, vast and towering modern mill. The self-sufficient pioneer household produced its own food, clothing, shelter, furniture, utensils and tools. For two hundred years such households were an important factor in the economic organization of America. Although after 1840 they ceased to make a notable national contribution, they still lingered in the eddies and backwashes; to this day they may be found in the mountains of Tennessee and Kentucky and in the Ozarks.

When the cabin was superseded by a frame house looking across cultivated fields to a road that led to a nearby village, around whose green central square clustered the white homes of the storekeeper, doctor, preacher, and various artisans, a new phase of manufacturing appeared. The services of skilled specialists, those who slept in hedges and worked in customers' kitchens as well as those who set up little village shops, supplemented the family labors.

As population increased and communication or transportation improved, the small village shop garnered to itself a greater share of the manufacturing for the surrounding countryside. At the artisan's shop the farmer swapped a hog for a harness, while his wife exchanged poultry for plaids.

The shop was succeeded by the factory filled with power driven machinery contemporary of steamboats and locomotives, and marketing its product over ever widening areas. Cabin, cottage, shop and factory signify the four stages in the evolution of American manufactures and since 1700 there has never been a period when at least three were not active at the same time. At

a particular place accessibility and density of population determined which phase ruled.

The Independent Household—The Frontier.—Stern necessity compelled pioneers to manufacture for themselves nearly everything they used. Isolated from the currents of commerce with little or nothing salable and no roads, each family was forced to depend on its own resources and skill. A frontier existed somewhere in America for two centuries. From 1640 to 1840 wherever the front of the migration paused household independence was a necessary phenomenon of the time and place. Even after 1840, despite all the amelioration rendered by railroads, steamboats, wireways and post office, those in the vanguard of civilization were forced more or less to live by their own efforts. Inasmuch as the frontier was the parent of household manufacture, the long continuance of the frontier explains the longevity of the most primitive industry.

British Colonial Policy.—An important compulsion to American household manufacture in our earlier years was the British colonial policy. The prevailing theory among the 17th and 18th century political scientists was that a colony was to be administered for the immediate benefit of the mother country. The colony was to supply raw materials and such manufactures as the home country lacked and, on the other hand, to purchase those commodities which the parent country furnished. Moreover, colonial trade should be controlled for the commercial advantage of the colonizer.

In compliance with these doctrines the British ruled that American commerce should be carried in British ships (including American) to British ports, particularly the commerce in certain specified articles. From time to time the colonists were forbidden to manufacture for sale certain goods that competed with the products of British workers. To encourage the production of particular raw materials or the manufacture of articles needed but not made by British artisans, import or export taxes were modified and bounties sometimes provided.

Until 1763 these regulations were of slight injury to Ameri-

cans, for when they did not serve American as well as British interests they either were laxly administered or totally ignored. However, they affected the north and south in different ways. American tobacco entered the British market under low duties and, if re-exported, the whole or part of the duties were repaid to Americans; the competing Spanish tobacco was excluded from British markets. Rice was given similar privileges, while indigo and naval stores were paid a bounty. The total effect of these favors was to stimulate southern agriculture and to pile credits with British merchants whereby British goods could be purchased and shipped to Maryland, Virginia and the Carolinas. Hence, there was no incentive for manufacturing in the south except in periods of low export prices. At such times the manufacturing on plantations was done by and used for slaves and servants.

On the contrary, the North and Middle Colonies produced little the British wanted. Hence, these colonies could furnish scant direct trade with Britain. For example, of the total exports from New England in 1769 the mother country took but 31% and from Pennsylvania 6.8%, whereas of the exports from Virginia and Maryland Britain bought 75%. In finding round-about methods of trade the northern colonists competed with the commerce of the mother country and were more or less restrained. Denied opportunity to earn the money to pay for British goods, the Middle Colonies and particularly those of New England were forced to make for themselves the things they could not buy. The British dictum that colonial manufactures could not pass in trade beyond the boundary of the place where they were made prevented much manufacture for sale. Consequently, the British colonial policy forced the middle and northern colonists to engage in household manufacturing.

That the British regulations were not unduly burdensome is proven by the fact that the colonists duplicated many of these measures. The latter were doubtless partly inspired by overseas authorities but many were spontaneous efforts of the Americans to solve their economic problems. It was not until after 1763 when the British under Grenville and Townshend added taxation to regulation that the American opposition waxed lusty.

Wars.—Wars always have stimulated American home industries. The wars in colonial days with the Indians or French invariably called forth an addition to household manufactures. This was partly an effort to supply the extraordinary needs of the soldiers in the battle lines, and partly a necessary reaction to the departure from the community of many skilled artisans. The interruption of the regular channels of trade blocked by war also compelled more or less reliance upon home production.

The longest period when wars, politics and international diplomacy forced household industry was from 1760 to 1820. These years might be called the heyday of family manufacturing. In the earlier part of the period resentment against British taxation of trade produced a rigorous boycott of British goods. Led by the "Daughters of Liberty," American matrons and maidens demonstrated that Americans by their own efforts could be independent of economic bondage to Europe. This object lesson gave courage to those who by war hoped to gain political independence. When the Revolution came it found the households prepared to provide for themselves and the American army, so that the British blockade was ineffective in beating the revolvers to their knees. The only exceptions in the Northern and Middle Colonies during the Revolution to American economic self-sufficiency were ports where the cargoes of prizes captured by privateers were auctioned, or territories held by the British armies. The Carolinas and Georgia were not so successful in standing on their own feet; as a result, throughout the war British and European goods in amounts only slightly diminished from pre-war importations flowed into that section. A century and a half of habit could not be broken by the relatively brief war years and, moreover, most of the battles were raging on northern soil.

The Revolution won, Americans indulged in an orgy of European manufactures, but soon scarcity of cash and tottering credit drove them back to their fireside occupations. There followed Mr. Jefferson's boycott and the War of 1812, both of which reproduced the industrial régime of the first war. Emergence from the War of 1812 witnessed another revelry in European wares. Meanwhile, the American factory system had started, so that when the post-war mania subsided America dis-

covered it possessed two industrial systems ; one, the time honored tested household manufactures, the other, the new, untried war baby, the power-driven factory.

It is interesting to note, despite the annihilation of home industries by the factory, that during the Mexican, Civil, Spanish and World Wars household manufactures to a certain extent were revived. The home work fostered by the 20th century Red Cross in the World War was analogous in kind, if not in relative amount, to that done by the "Daughters of Liberty" in the last quarter of the 18th century.

Hard Times.—Back of the frontier, household industry for a long time languished or flourished according to market conditions. Glutted markets meant low prices. With less income settlers could buy less of goods manufactured abroad or in the east. In such circumstances the dust and cobwebs were brushed from the household tools and machines, and the family subsisted by its own enterprise as long as the depression lasted. This was equally true of Massachusetts in 1700 and Wyoming in 1900.

Minor Incentives to Household Manufacturing.—Enough has been said to see why household manufacturing was so firmly imbedded in American economic organization. But there were several minor inducements to such employment. Almost every farmer kept sheep, not solely for their meat nor wool, but because they aided in clearing land and in keeping it free from weeds or brush. Incidentally, the sheep also aided materially in fertilizing the soil. Sheep then furnished many utilities; the one which was dominant at a given time depending on circumstances. The wool from these many-purpose sheep had to be worked into yarn and cloth by the women of the family. Wool was an otherwise wasted resource unless household manufacturing rendered it useful.

There was a similar situation in regard to cattle and their hides and hair. Tanning and manufactures from leather were household industries, partly because the home possessed a valuable but unsalable raw material which had to be converted to useful forms in order to be saved. Cattle hair was used as a tex-

tile fiber. Some household manufacturing thus performed the same function as pigs at a dairy.

What applied to the foregoing raw materials was also true of *time* and *labor*. In the northern colonies and later settlements the winter was a season when outdoor tasks were limited in number and restricted by the shortness of daylight hours. In an age of deficit there was no place for leisure; hence, the winter was a period of active household manufacturing, particularly on the part of the men and boys. At all seasons the large families of girls were kept busy at various kinds of manufacturing, often through the necessity for the products of their work, but also so that their labor power might not be lost. All of this business was supported by the prevailing belief that Satan would find tasks for idle hands to do. Heads of households, therefore, made their children work to beat the Devil.

The Products of Household Manufacturing.—The work of the males of the household began with the dwelling itself. The cabin or house was built sometimes by the men of a family without any outside aid, but where there were neighbors home construction was cooperative. Within the house, before the coming of cabinet makers, all the furniture, cupboards and shelves were the work of the men of the family. Much of the kitchen and table ware, also, were the result of their work upon wood or leather. They, too, manufactured farm tools and equipment, as well as harness, saddles and yokes for the work animals. Broom making was another manly art and the preparation of flax by braking and swingling, as it was heavy work, was allotted to the men. All the working of hides and manufactures from leather fell to the men, even when it was leather clothing that was manufactured. Of course, the men were the shoemakers and they, too, made as well as drank most of the alcoholic beverages. Although the men of evenings often hammered out nails and tacks, we do not include them in household manufactures, since these were for sale or barter rather than for use.

This suggestive rather than exhaustive list of the manufacturing done by men pales into insignificance when compared to the work done by the women and children. All the cooking and

preservation of foods fell to them. Butter, cheese and syrups, pickles, sugar and preserved fruits or vegetables, all were prepared by women. Women manufactured all the fibrous clothing, whether it was for the man of the house, the table, the tub or the bed. All the raw materials from which clothing was manufactured were products of the women's labor. That is, they sewed together a coat; they wove the cloth from which the coat was cut; they spun the yarn by which the cloth was woven; they prepared the fibers for spinning into yarn; and they not only did the dyeing but made the dyes. The whole textile field was woman's domain. Wool, flax, hemp, cotton—obtained from the West Indies—nettles, silk and cattle's hair furnished the raw materials which she carded, combed and spun into yarn. Not only cloth for outer clothing was woven from the yarn but underclothing for both sexes and narrow webbing for such different things as suspenders and horse halters. Some of the yarn was knitted into hosiery, mittens, jackets and scarfs, and a portion of it used for "fancy work" on utilitarian objects.

When pine knots were replaced by candles the women prepared the candle stock and manufactured the candles first by repeated dippings, later by pouring into moulds. For special candles the women collected bayberries, removed their wax and made the candles. Soap manufacture was another feminine occupation. In short, women manufactured over a hundred different things, all requiring some skill. To learn all these trades, besides the regular duties of a housewife and mother, caused a girl's instruction to begin at about the age of five and continue for fifteen years. The farm work of men was arduous, sometimes dangerous, but women's work was tedious and without end. Gallatin's Report on Manufactures made in 1810 estimated the total yardage of goods made by women in the home as 72,371,564. This was more than six yards for every female then living in the United States and was only one of the manifold manufactures carried on by women. In fairness, however, it should be stated that the year the data for the Gallatin report was collected was one of extraordinary household manufacture, coming as it did after Jefferson's Embargo and Non-Intercourse Acts and just before the opening of the second war with Britain.

Itinerant Craftsmen.—Household manufacturing in its extreme degree of independence did not endure long at any time or place. As soon as permanent settlements were made craftsmen began to appear. The tasks they usurped were those requiring special skill or unusual strength. The households continued to furnish the raw materials, to use the finished articles and to have the work done on the premises, but wandering craftsmen rather than members of the family did the actual work. Thus, there were itinerant weavers, shoemakers, butchers, tanners, tailors, and clothiers (wool cloth finishers).

These men, carrying the tools of their trade, went from home to home, lived with the household, and applied their arts to materials made ready by the family. Being travellers, their news and tales of adventure were nearly as welcome as their workmanship, so they were rarely turned from the door. The duration of their visits was determined by the amount of work waiting for them in the family.

Hand weaving was not only skilled but severe, so the women were happy to be relieved of this task. The tailors manufactured clothing more expeditiously and neatly than the women and with greater style. The clothiers who finished wool cloth had the strength which women lacked to handle the stiff loomed-cloth as well as the skill to cut or raise its nap and to press it smoothly. The shoemakers, butchers and tanners lifted these jobs from the hands of the men of the family. Each trade was an art. No householder could be equally skilled in all of them, nor could he often be as proficient in any one as the man who made it his livelihood. So the journeying craftsmen filled a real need and were correspondingly popular. The only modern survivors of this system are the scissors grinder, umbrella mender and tinker.

Craftsmen's Shops.—As roads were built and the countryside filled, the craftsmen ceased roaming except for brief excursions to far outlying homesteads. Instead, the farmers brought their materials to the village where the craftsmen had opened little shops. Sometimes farmers rode as much as fifty miles into a village to get work done. The consumer was still the furnisher

of the raw material but his home was no longer the place where the special tasks were performed.

The village community supported several new craftsmen who opened shops but who never had been rovers. Among these were the leather workers,—the curriers, saddlers and harness makers. After leather came from the hands of the village tanner the currier finished it by making it pliable, durable, and giving it color. The saddlers and harness makers worked leather into the products of their calling. There were also masters of wood craftsmanship. First was the joiner, a kind of high grade carpenter, then the cooper who made casks, hogsheads, vats and barrels, and the cabinet maker who was sometimes an artist as well as a skilled worker. There were three smiths—the blacksmith who wrought with iron, the whitesmith who fashioned silver, and the gunsmith who doctored sick firearms. Finally, there were the wool carder who prepared wool for spinning, and the barber who shaved, clipped, curled and pomaded his customers.

Village Mills.—Antedating the craftsmen's shops in many instances were the village mills. Generally the first to appear was the grist mill, for it relieved the family of the daily labor with mortar and pestle, the muscular as well as time consuming task of reducing grain to flour. Indeed, the grist mill was so eagerly sought that special public inducements, such as relief from taxation or military duty or a bounty paid out of the village treasury were offered private individuals to erect one. If these measures failed, public or cooperative grist mills were built and operated. The power to run these mills was human or animal muscle, wind or water.

Following close upon the grist mill was the sawmill, whose lumber or shingles were superior to the hand hewn products of the householder. Saw and grist mills were often housed in the same building and operated with the same power. Where water power was used both mills, if they were not in one structure, were generally on the same creek.

Another member of the early trinity of village mills was the fuller's establishment, as intimately related to the other two as they were to each other. Fulling consisted of washing wool cloth

with warm water and dissolved soap, softening the surface by the insertion of short fibers of wool, beating the cloth with sticks or mallets, and lifting the nap with teasels. Dyeing also might be part of the procedure. Finally, the cloth was stretched upon a frame (tenter) with hooks (tenter-hooks) and left to dry evenly at full width. This job was so laborious and specialized that both the women and men of the household forsook it instantly when a fulling mill was established anywhere within reasonable distance.

Characteristics of Village Industries.—The craftsmen's shops and the village mills were almost entirely local in character. They derived their raw materials from near at hand, often from their customers, transformed the materials in the community and sold or bartered the finished product in the immediate locality, sometimes taking pay in kind. The whole cycle of activities from crude stock to final form was carried on in the same area.

All such local industries had several common features. They dealt in articles too cheap or too bulky in proportion to their value to warrant importation or too specialized to be made in the homes. Yet the manufacturing processes were simple, and usually without division of labor. They involved little fixed capital and the commodities made were in universal demand. These village enterprises were common in all the Middle and Northern Colonies and many of them later reappeared on the frontier during the westward advance.

Production for Sale.—In contrast with the village industries which supplemented household manufacture there were craftsmen, sometimes of the same trades as those in the villages, who made goods for sale in a market without advance order or acquaintance with the buyer. A few of these were found in the middle colonies, but they were pre-eminent in New England.

New England was unlike her sister colonies in many respects. She could not support herself solely by agriculture. She had no raw materials that England wanted except forest products. Since there was slight basis for direct trade between the mother country and her American namesake, New England, as a result, sought for

wealth by methods that were not necessary anywhere else in America. Denied sustenance from the soil, she found succor from the sea, and, as the best fishing grounds in the world were near her coasts, New England gained fame from her fleets if not from her farms. The outgrowth of the fishing industry was the rise of commerce and shipbuilding as New England's principal sources of livelihood, and these two enterprises in turn were responsible for giving to New England many manufacturing ventures. Most of the manufactures originated from the fact that they either supplied materials needed for shipping or else put into finished form raw materials brought home to America by returning merchantmen.

Ship Outfitting.—In the first group fell all those manufactures that outfitted ships for their voyages. The iron industry was one of these, furnishing nails, bells, cannon, shot and anchors, and it is significant that Massachusetts led all the other colonies in iron manufacture for a hundred years after 1650. Besides iron, rope was a requisite for ships. The first rope walk was set up at Boston in 1641 and soon all the ports followed Boston's lead. As a reflex of this early industry, one of the largest rope plants in the United States today is located at Plymouth, not far from the famous Rock. Not only iron and rope but food products also were needed by every outgoing vessel; flour mills, biscuit makers, and salt meat packers were therefore common sights in every great shipping town. It is interesting, too, to discover that the present-day ready-made clothing industry has grown out of tailor shops that faced the docks and made suits for sailors. In the group of activities, called into existence by the needs of merchant vessels, should be placed the big cooperage industry. Flour, biscuits, meat, rum, sugar, molasses, oil and naval stores—in short, every principal article of commerce—were transported in hogsheads or barrels. Cheap wood of high quality gave New England such an advantage in cooperage over her foreign competitors that it was estimated that our merchants could count the cheapness of their barrels as at least an extra 15% profit. Small pails, large buckets, hogsheads and staves made of white oak were themselves articles of commerce, especially to the West Indies, where they were

needed for containers for sugar, molasses, and rum. In 1671 New Hampshire alone sold abroad 20,000 tons of boards and staves.

The refining of salt from sea water was an industry conducted along the entire New England coast. The salt derived by evaporation from sea water was in constant demand for preserving the foods carried as stores on long voyages. Salt itself was necessary for fishing boats, used by them to preserve their catch.

Distilling and Refining.—Contrasted with these industries which supplied outbound boats were others that were supported by raw materials brought home by incoming vessels. Among the most important inbound cargoes were raw sugar and molasses. These raw materials gave rise to two manufacturing industries in New England ports; one, the refining of raw sugar, the other, the distillation of rum from the molasses. The latter was given preference because rum was in great demand both for domestic and foreign trade. Another distilling industry located on Massachusetts Bay was that founded on fishing. Non-edible fish were distilled in order to yield valuable oils. For scores of years fish oil was the only source of lubricants and illuminants.

Not only raw materials for distillers and refiners were in the holds of returning ships, but also hides collected from foreign ports scattered all the way from Cape Horn to Santa Barbara and many Pacific islands in addition. These hides were tanned near Boston and manufactured into shoes at Lynn. Although shoe-making was a local industry in all the settlements, nevertheless Lynn became the leader in this industry.

The fishing and commerce of New England, therefore, were responsible for the early trend towards manufacturing in that section of the country and marked it as an incipient industrial region.

Large-Scale Village Shops.—Usually it is assumed that the characteristics of the modern factory which distinguish it from preceding organizations of production are the aggregation of many like workers at one place and the use of power machinery. This accepted notion is not literally true, for aggregation of

craftsmen under one management and housed under one roof appeared in industry long before the introduction of power machinery. Large-scale shops were found in villages where they supplemented household manufactures, and also in the port towns where they were most likely to be engaged in production for sale. Both in Europe and America there were craftsmen's large-scale shops prior to the industrial revolution; indeed, such organizations were not unknown when Rome ruled the world. While in both continents these large shops were unusual they point unmistakably to the fact that promoters were feeling their way toward the factory system long before power machinery gave the basis for its sweeping adoption.

The records of Massachusetts, New York, Pennsylvania and Virginia describe incipient "factory" enterprises before the Revolution. The earliest aggregations of workers seem to have been motivated by pedagogical, penal, or charitable, rather than economic reasons. Thus, schools for the teaching of spinning were started in Jamestown in 1646, followed by similar institutions in Boston, New York, Philadelphia and Baltimore. Likewise convicts penalized for minor offenses were put to work in groups for spinning and weaving. Houses were set apart also in some of the cities mentioned where the children of the very poor and destitute females could learn a trade—generally one of the textile pursuits—and earn their keep. The first craftsman of whom there is record as employing several helpers in one place was a Boston linen weaver, whose estate, probated in 1696, revealed that he hired several spinners and supervised their working together in one room. Probably the largest pre-factory "factory" was that operated by William Molineaux of Boston.

A few places had so many craftsmen engaged in one kind of work that the town became noted for the product long before power machinery was invented. Germantown, now a part of Philadelphia, was famous for its knitted stockings. Lynn, after 1750, was so associated with shoe-making that the name of the town suggested the footwear made there. Lancaster, Pennsylvania, the largest inland town before the rise of Pittsburgh and Cincinnati, was the last outfitting place for migrants going west.

Most of its population were engaged in some kind of manufacturing, but the largest aggregations were the metal workers and weavers.

As a center of mills using water power, Wilmington, Delaware, had the highest reputation. In the latter part of the 17th and the first years of the 18th centuries it was as famed for flour manufacturing as modern Minneapolis. Surrounded by grain farmers, with ample power in the Brandywine, and with deep-water transportation on the Delaware, it boasted leadership in flour manufacture until grain growing moved northwestward.

Among the trades that were represented by large-scale village shops employing many craftsmen of the same kind were tanning, shoe-making, coopering, tool-making, weaving, brewing, hat-making, baking, and printing.

The economic advantages gained by these craftsmen's large-scale shops were closer supervision of workmanship, finer division of labor, detection of theft, saving of time over household visitations, and larger or cheaper output. The shops were natural growths. Sometimes they started when a craftsman hired a helper or two and then expanded until the craftsman became a merchant-manufacturer, buying raw material, supervising production and selling the product. In other instances storekeepers or merchants handling raw material put it out at first for manufacture in homes, and then called together under one roof some of the former household workers.

These relatively large-scale craftsmen's shops represent a transition stage between household manufacturing and the modern industrial system. Therefore, there was no one single type of shop, for men were experimenting more or less consciously with several forms of organization. Though these experiments were not numerous, and at the time were not much noticed, it is now seen that they were laying the foundation for the factory system.

It is worth noting that modern sanitary potteries are more related to aggregations of craftsmen than to the factory system; this industry might serve as a present-day example of an otherwise vanished regime.

Survivals of Household and Handicraft Production in the Factory Era.—It is said that the American factory era began in 1790, when Samuel Slater started a spinning mill at Pawtucket. This event, however, did not end household manufacturing. Indeed, for a quarter of a century after Slater's venture the cotton mills were merely spinning establishments furnishing yarn to household weavers or to village craftsmen. The early mills specialized in the production of warp yarns because these were most difficult for women to spin at home, whereas the women had no trouble in spinning weft yarns. It was not until 1814 when the American power loom was invented and installed in a factory at Waltham that household cotton manufacture began to decline. The application of machinery to wool manufacture was much slower; indeed the first wool machines were designed as aids to household manufacture rather than as the basis for factories. It was 1830 before wool mills made serious inroads upon household wool manufacture.

In the middle of the 19th century the invention of the sewing machine, followed by its adaptation to power propulsion in many different types of work, probably struck the hardest blow at household and handicraft production which these systems sustained after the power spinner and loom were introduced. The shirt, collar and cuff factories began with power driven sewing machines. Shoe-making was lifted by these machines from the craftsman's shop, with its supplementary home work, to the factory. Likewise, the ready-made clothing industry, catering to all the members of the family, was created by the power sewing machine which well-nigh annihilated the village tailors or dress-makers and rendered ridiculous the faulty workmanship of mothers or sisters. Yet everyone knows that the sewing machine also was a household appliance. There are plenty of housewives still who make shirts for their husbands, underwear and clothes for their children, to say nothing of hand knitted stockings, mittens, leggings, and mufflers. Moreover, many women wage earners, utilizing their own sewing machines perform detailed operations on materials let out to them by factories.

The food industries shifted from the kitchen to the factory even more slowly than the textiles. Meat packing with all its by-

products has been the most successful factory invader of the domains of butcher and cook. Creameries where butter, cheese and evaporated or condensed milk were produced have taken a great deal of women's work out of the home. Canneries, originally designed to save the waste of surplus fruits or vegetables and operated only for a brief season during harvest, in many instances have grown to mammoth proportions running continuously through twelve months. To the preservation of fruit and vegetables they have added the manufacture of soups, pickles, jellies, preserves and sauces. This whole branch of the food industry has challenged the skill of the thrifty housewife. Home-made maple sugar or home produced honey have given way to factory refined cane or beet sugar. Slippery "ellum" and spruce gum were made obsolete by manufactured chewing gum. Finally, the village baker and the housewife have been threatened by the factory producers of bread, cake, cookies, crackers, pies and pastries.

Nevertheless, many a farmer even yet butchers his own hogs, makes his own pork, ham, sausage and lard. Moreover, the local butcher of cattle, sheep and lambs still does a flourishing business. Many a housewife still churns butter and makes cheese, besides "putting up" dozens of glasses of preserved fruits, vegetables, jellies, and the like. Probably a majority of home mothers scorn the bread and pastries made in factories, preferring the products of their own skill and cook-stove. Some housekeepers manufacture their own yeast and soap. The householders most fully emancipated from household manufactures are the dwellers in city apartments, but even these, despite their active patronage of department stores, the corner grocery and the delicatessen, are not completely relieved from traditional household occupations. Industrialization has not been so complete as casual observation would lead us to believe.

As contrasted with household or handicraft manufacture the factory system has given us more of a given commodity at a lower cost and price. It has enabled us to manufacture things such as locomotives, giant travelling cranes, or steel pens which no home workers could possibly produce. While the factory in general has not changed the traditional division between the work of men

and women, it has in some instances enabled each to invade the field of the other. For example, in factories men may make shirts and women may operate metal planers. But factories have greatly specialized the work of both men and women. From Jacks-of-all-Trades—and Jills—they have become artisans in a tiny division of one trade. Moreover, the work-place and all its surrounding environment has been altered radically by the factory.

Whether mankind is happier or better off under the factory regime than under the household and handicraft systems is a question mooted by philosophers. Besides defining "happiness" we should remember in answering this question that the household system, since it belongs to the past, has a golden halo which those who lived under it, especially the women, were unable to observe, and that the factory system, despite its century and a quarter of life, is still too young to have developed adequate social adjustment.

CHAPTER V

THE DEVELOPMENT OF THE FACTORY SYSTEM

Introduction.—When the Lexington farmers “fired the shot heard round the world,” America was an agricultural country. At the time the world was set ablaze by the German invasion of Belgium the United States was the greatest of all the manufacturing nations. Beginning in 1790 with one little spinning factory employing nine persons, the number of American manufacturing establishments swelled to 200,000 by 1927, paid wages to 9 million employes, and produced wares valued at more than 60 billion dollars. But it was not until 1830 that the two branches of manufactures developed—cotton and iron—made such progress. For that matter, American manufacturing of the factory type labored under heavy handicaps until the time of the Civil War. It was not until after Lee’s surrender that Americans really discovered their unusual resources and advantages for manufacturing. The full utilization of the factory system, therefore, is a relatively new thing in the economic life of the United States. American manufacture rose from relative obscurity to world prominence in the span of a man’s life, for the great change took place between 1870 and 1920.

Hindrances to Colonial Manufacturing.—The foremost disadvantage confronting an enterprising colonial craftsman who might have endeavored to start manufacturing for sale in a market was the natural predilection of a new country toward the extractive industries—agriculture, forestry, mining and fishing. Not only were the extractive industries necessary to sustain life in a virgin land, but wherever there existed a surplus over domestic requirements within access of the ocean, the foreign markets were ready to absorb it. It paid our colonial ancestors to sell extractive products and with them purchase European manufactures.

Labor Scarcity.—Another characteristic of a newly opened country that was inimical to manufacturing was the relative scarcity of labor. At no time in the 17th century did the total population of the colonies exceed 250,000. It was 1720 before the population reached a half million. After that there was an acceleration in numbers so that by 1740 the million mark was passed, and twenty years later the second million reached. Nevertheless, at the outbreak of the Revolution the total population was about 2¼ million, and this meager collection of souls was spread from Massachusetts to Georgia. Throughout the 18th century Massachusetts had the largest population of the thirteen colonies, but even in 1775 her total was only 350,000. Pennsylvania at that time was the only other colony that approached this figure, although Virginia claimed 300,000, and both Connecticut and New York had each more than 200,000.

As a consequence of the sparsity of the population and the abundance of land wages were high and farms cheap. Wages ranged from two to six times the cost of living. As late as 1830 a mechanic could save enough in four to six months to buy an 80-acre farm. Farmers, to secure permanent labor, had to resort to imported convicts, indentured servants, and slaves.

The craftsman who was ambitious to expand his operations was halted by the lack of labor. If he hired skilled journeymen they soon left to become proprietors of land or masters, while the classes of labor employed by farmers could not be used by the craftsman on account of their ignorance of his trade. This condition operated forcibly in restricting manufacturing enterprises, to say nothing of the handicap imposed by high wages.

Lack of Free Capital.—Just as the newness of America made wage labor well-nigh unavailable, so also the recent origin of the colonies created a dearth of floating capital. Whatever capital was present immediately assumed fixed forms. It went into buildings, cattle, work animals, or tools, and left but little free to conduct a going business. Free capital was so rare and had so many demands for its services that interest rates were prohibitively high. Hence, even though manufacturers might be able to

start with their own financial resources, they could not have borrowed funds for running expenses or for expansion.

Money Confusion.—One of the most perplexing unsolved problems the colonists faced was the insufficiency of circulating money. Since the coinage of money was a prerogative of the king, the colonial governments had no mints of their own, and, inasmuch as the balance of trade constantly was against the colonists, what little money they possessed tended to flow to Europe.

Under these circumstances, the early Americans reverted to the first principle of trade, namely, exchanges by barter or direct trading of goods for goods, despite the manifold and manifest inconveniences of this system. In addition, they adopted primitive mediums of exchange, selecting specific commodities to function as money. Among the articles chosen at different times and places were shells (Indian wampum), beaver skins, tobacco and tobacco warehouse receipts, rice, "corn"—generic for all grains including peas—bullets, powder, fish, sweet potatoes, deerskins, raccoon skins, hogs, sheep, turkeys, pieces of soap, and puppies.

Despite the fact that all accounts were kept in terms of British money, there were few British coins circulating in America because trade drained them home. Instead, Spanish "pieces of eight"—eight reals worth about \$1.25—Dutch ducats (worth \$1.20) and six dollars (36 to 80 cents), were the most common coins. Aside from these silver coins there were minor coins worth a few pence and made from copper, brass or tin, stamped with the insignia of Britain, Spain or Holland. Of all these coins the ones that were full weight and had not been badly worn, clipped or sweated went abroad in payment of debts. Only the light-weight, depreciated coins remained in colonial circulation and these were counterfeited by wholesale.

During the disturbances at the time of Cromwell, there being technically no king whose prerogative could be violated, the colony of Massachusetts established a mint where from 1652 to 1686 shillings were coined. A hundred years later this mint was reopened for two years until Congress ordered it closed. Lord

Baltimore, about 1660, attempted to mint his own coins for Maryland but was prohibited by the masters of the British Mint.

Hard pressed as they were, the colonists unwisely met the deficit in circulating media by issuing paper bills of credit, that is, paper money, beginning in Massachusetts in 1690. Thereafter, the various colonies flooded the markets with issue after issue of irredeemable paper notes. These not only depreciated rapidly but were grossly counterfeited.

With the money situation so confused it is incredible that colonial trade in extractive products reached the proportions it did; the fact proves that necessity hurdles all barriers. However, the chaos of currency, added to the other financial difficulties facing a promoter of manufacturing, effectually quenched his enthusiasm or brought about speedy downfall.

Lack of Markets.—Under the conditions in respect to labor, capital and circulating money, the only types of manufacturing open to Americans were those that produced commodities for everyday use or those wherein the separation from Europe in distance and time gave advantage to a domestic enterprise. But American households produced their own common necessities and looked to the towns only for luxury wares. Our manufacturers not only could not produce these under American circumstances, but could not have sold them if produced for the people preferred a European label as a guarantee of quality on the few articles purchased. As for the factors of space and time, our citizens had no advantage, for overland transportation was impossible and any place available to Americans by water was equally accessible to European producers. The only possible market therefore for American goods was in the immediate locality where they were made.

Handicap of British Law.—Since the universal colonial policy at the time of American settlement was to exploit the colony for the benefit of the mother country, the British followed custom in encouraging America to produce raw materials which could be shipped to England in exchange for British manufactures. Naturally, any tendency upon the part of Americans to set up their

own manufactures was restrained. Thus, in 1731-32 when British hat-makers complained about the growing domestic hat manufacture of America, Parliament prohibited the Americans from continuing the competition. When, in the early 18th century, the iron industry of England was on the decline because the forests that supplied charcoal were exhausted, the colonists were exhorted to erect furnaces in order to supply England with pig iron, but were forbidden to fashion the pig iron into any finished form whatever. Later when a substitute for charcoal was found by distilling British soft coal into coke, an edict was issued against colonial manufacture of pig iron. Again, in 1744, England forestalled American competition in textile manufacture by declaring it a misdemeanor to ship the improved textile machinery out of England. Subsequently, with later advances in machinery the law was made more rigorous and comprehensive. In short, England was at a more advanced economic stage of development than her colonies and she intended that the gap should not be lessened.

This policy nipped in the bud all those incipient manufactures that showed likelihood of success in competition against England herself. This British attitude, therefore, added to the dominance of extractive industries and the lack of labor, capital, money and market, made it impossible for manufacturing to gain great headway in the colonies.

Revolutionary War.—Then came the Revolutionary War, ushering in a new era with different conditions. During the Revolution the American market, so long dependent upon foreign manufactures, suddenly was thrown upon its own resources. Imports were shut off, with the result that commodities customarily imported increased in price. On the other hand, raw materials usually sent abroad likewise were stopped at the docks and thrown back to American consumers. With high prices for finished products and low prices for the crude stock, an alluring profit was held before American enterprise, in immediate response to which manufacturing started up.

Effect of Revolution.—But this manufacturing endured only so long as the war which produced it, for when the war was fin-

ished a flood of British goods entered our markets and almost completely swamped our young industries. The British had the advantages of low wages, permanent working classes, great subdivision of labor, and relatively large-scale production. Moreover, they had a monopoly upon technical improvements in both textile manufacture and iron production. In textiles, the spinning jenny, the spinning mule, the application of steam power to spinning, power looms, cylinder printing, and chrome bleaching, all were English inventions and had been introduced in England's factories exclusively; in truth, they were the direct cause of the industrial revolution. In iron and steel manufacture, the use of coke, Cort's puddling furnace, and Cort's grooved rolls were again English inventions. England kept these inventions for herself by imposing fines and imprisonment upon anyone attempting to carry them from the country in the form of machines, parts, plans, or even in the persons of skilled artisans.

Against this array of benefits, the Americans could set the distance that separated English producers from American consumers, freight rates acting as a tariff in favor of Americans. In addition, the Americans were blessed with relatively low taxes and low-priced materials. In the long run these advantages counted against the British after we had smuggled, stolen, or invented machinery to offset their technological superiority. For the time being, however, with all the goods on hand accumulated during the war, the British were able to sweep our market. So our young manufacturing enterprises swayed, tottered, and almost crashed into complete ruin.

The American situation was soon relieved by the international upheavals wrought by Napoleon. These benefited Britain by restricting continental competition and giving her free rein to develop her own industries. Since she had the European markets, Great Britain was less concerned with the American. At the same time, American commerce profited amazingly by the struggles abroad and brought to Americans much capital that they sought to reinvest. Although much of it went into the enlargement of shipping facilities, some was diverted to the support of manufactures. This tendency was greatly increased by the Embargo (1807) and Non-Intercourse (1809) Acts which blocked

foreign importations and tied up our own vessels. Merchants withdrew their capital from commercial ventures and put it into factories, the exclusion of foreign-made goods giving them an excellent opportunity to succeed. The War of 1812 following soon afterwards was the final factor favoring new manufacturing projects.

Factory System.—The situation of American manufacturers during and after the second war with Britain differed in two marked ways from their situation at the time of the Revolution. The Revolution had brought an expansion of household manufacturing, but the War of 1812 firmly established the factory system in the United States. The second characteristic that made 1815 different from 1782 was the rapid subsidence of the sudden and fierce foreign competition that arose at the close of the war. Our manufacturers were not in the weak condition that enfeebled them after the Revolution; our political status was no longer chaotic; our internal affairs had been adjusted. Then, too, our merchants soon exhausted their money or credit and so could not pay for foreign goods. Finally, the British were engaged in a peaceful conquest of continental markets and consequently did not bring excessive pressure to bear to save the American market. Since the period of suffering for American factory-owners was not greatly prolonged, it served merely to weed out the weakest, leaving the strong in a good position to seek control of their own domestic market.

We are prone to look upon the British as invaders of our field of operation in these two commercial contests after political wars; we speak of their efforts to regain a foothold here as "raids." As a matter of fact, it was the British who, previous to 1776 and largely before 1812, had possessed this market; their struggles were really to protect what they considered their own. We were the upstarts who routed their commercial forces and finally drove them back into the sea, claiming for ourselves a market that never before had been ours, but which we naturally deemed our lawful prize.

Rise of Cotton Manufactures.—Of all the great manufacturing industries cotton was the only one that had no handicraft

traditions to hamper the introduction of the factory system of production. Any operation calling for skilled male manual labor would have failed in America if forced to fight against foreign competition, because our male workers were few in number and highly paid. But cotton manufacture was not only conducted by machines but demanded unskilled female attendants. Of these there was no dearth, for up to the opening of the Waltham cotton factory there was no means by which a woman could be economically independent, yet there were scores of widows and unmarried women who were galled by the necessity of appealing to male relatives for charity. These women hailed factories as their liberators from economic slavery. To their number were added the young women who were attracted by the spirit of adventure or the desire for an extra or a personal income. Hence the usual handicap against an American manufacturing undertaking, namely, the lack of labor, was not existent in the case of the early cotton mills. The lack of capital, too, that heretofore had checked the growth of manufacturing was removed from the organizers of the cotton industry, for the expansion of the factory system came at just the time when there was a contraction in commercial profit and merchants sought new avenues of investment.

New England Takes Lead in American Cotton Manufacturing.—With labor and capital requirements satisfied, the next requisite was water power. The eastern part of the United States, especially New England, was splendidly endowed by nature with power sites. The place that brought together labor, capital, and power was the natural location for the new industry; and New England was that place. Sailors' wives, sisters, or daughters, or the female members of farmers' families struggling against debt upon an unproductive farm, constituted the labor. Boston, Salem, New Bedford, Providence and New Haven were commercial capitals where many a citizen of wealth was anxious for lucrative investments. Countless brooks, small streams like the Blackstone or the Quinnebaug, and larger rivers, such as the Merrimac or Connecticut, furnished the power. As a result, New England immediately took the lead in cotton-making and for nearly a cer-

ture her commanding position was scarcely jostled. By 1830 the New England mills were able to furnish the domestic market with the ordinary grades of cotton cloth and had little to fear from foreign competition.

Iron Manufacture.—Not only cotton but iron manufacture, also, emerged from obscurity between 1814 and 1830. The reasons for the growth of the iron industry were the demands for iron tools upon the rapidly multiplying farms of the Middle West, and the use of iron in textile and other machinery in shops whose sole output was machines. The iron industry, however, did not make any such startling strides as the cotton, for there was then no such market for iron as existed for cotton cloth.

Wool Manufacture.—The wool industry struggled in the wake of cotton, but far behind it. For instance, power weaving was common in cotton manufacture twenty-five years before it was general in wool. Bound by handicraft traditions, upset by frequent changes in style, shackled by difficulties with raw materials, and pressed by the severest foreign competition, nevertheless the wool industry before 1830 sought to profit by the example of its sister textile, and adopt machine methods of production. That the factory system did not so quickly prosper in the wool as in the cotton industry was not due to absence of effort on the part of promoters but to the complications inherent in an unstandardized raw material and a non-uniform product.

The Influence of Railroads.—Between 1830 and the Civil War the most profound influence brought to bear upon American manufacturing was the introduction and extension of railroads. At first radiating from eastern cities or joining navigable waterways, the railroads were gradually interconnected, consolidated into systems and extended to the Mississippi.

By affording speedy land transportation the railroads broke down the necessity for purely local industries and permitted the segregation of manufactures where they could be conducted most economically. Not only were existing markets opened to everyone but new markets were created by the tapping of hitherto inaccessible regions. This broadening of market permitted large-scale

production with its economies. Railroads enabled farmers to differentiate their crops, and the resultant money crop agriculture created a demand for all those things each farmstead formerly had produced for itself. Moreover, railroad facilities led to the multiplication of farms.

Labor.—One marked effect of the early railroads upon manufacturing was the enlargement of the labor force. The railroads brought farms everywhere in the east into active competition with each other and with the new lands west of the Appalachians. Those in the best location, with the best soil, and under the best management, undersold the inferior farms and farmers. Many of the poorer farms had been hard hit already by the Erie Canal, but the railroads delivered a finishing blow. Hence, the farms such as economists classify as “producing on the margin” were abandoned to their fate and their former owners sought refuge in factories. Labor seeking factory jobs was a novel experience for America where manufacturers were accustomed to combing the highways and byways to induce workers to accept places in the mills.

Machinery.—During the thirty years prior to the Civil War our manufacturing made startling technological advances. First, the primary motive power was greatly increased in capacity. Beginning in 1830 steam engines began to supplant water power, and the consequent competition between the two sources of power brought marked improvement in both. Engines were reduced in cost both for installation and operation and increased in capacity and efficiency, while water power was bettered by the invention and perfection of hydraulic turbines.

Secondly, the machines already in use in the factories were bettered in detail and new machines were introduced. Among the most important of the new machines was that for sewing. The adaptation of this one basic machine to different tasks on various materials revolutionized a half dozen industries in which sewing operations were paramount.

The use of machines called into being a whole new industry, that in which machinery for other factories was the product. At

the start of this branch of manufacture the principles of standardization and interchangeable parts were adopted. Eli Whitney first had applied these principles with profit in the manufacture of firearms, and they were the secrets of the instantaneous success of the sewing machine business. Later, the same principles applied in the manufacture of watches, agricultural machinery, typewriters, and automobiles gave to America its greatest renown as a manufacturer. It is important, therefore, to note that our machine shops from the beginning endeavored to turn out standardized machinery with interchangeable parts.

Up to 1830 manufacturing had counted for little in the national life, but in the next thirty years it took firm root.

Chaotic Currency.—Probably the most serious bar to full development of our manufactures between the time of Washington and Lincoln was the chaotic condition of our national currency.

During the Revolution the Continental Congress not only repeated the errors of the colonies in issuing irredeemable paper notes but ran the presses overtime. By 1779 no less than \$241,500,000 in bills had been dumped upon the public. It is true that no other course seemed possible, but the effect was so disastrous that the very phrase "not worth a Continental" has become a term of derision and contempt.

Until the Civil War it was tacitly assumed that Congress had no constitutional power to order issues of federal paper money. The two attempts to establish United States Banks had got entangled in politics and failed; consequently, there was no official federal authority capable of issuing paper money. This intensified the evils of paper money, for the privilege of issuing it was left to the state banks. As most of the states, partly through ignorance and partly by the political pressure of needy constituents, were lamentably lax in their banking laws, the result was a host of poorly managed or deliberately dishonest banks which issued notes in reckless quantities without much regard to security or redemption.

Every bank note received in trade, therefore, had to be scrutinized with the utmost care. To determine its actual current value it was necessary to consult one or more books or tables

published for that purpose, and these never could be up-to-date. Disasters were frequent and losses enormous due to unwary acceptance of bank notes.

The inordinate inflation of the currency traceable to unregulated issues of bank notes led to several periods of frantic speculation. One of these was in the years from 1812 to 1816, and another in the years from 1837 to 1846. Deflation, or even hints of it, caused widespread panics with consequent wholesale losses. Some states, as for example, Massachusetts, Indiana, Louisiana and Ohio, and many individual banks elsewhere, took a proper conservative attitude toward banking, but even these could not escape all the results of "wild cat" banking. For half a century banking and crookedness were well-nigh synonymous.

The situation in respect to metallic money was not much better. Notwithstanding that a Federal Treasury Department was created in 1789, and by Congressional action, a coinage system and a mint were established in 1791-92, the difficulties that had arisen in respect to coins during the colonial period did not cease. Some foreign coins continued to circulate as legal tender in this country as late as 1857. To those older uncertainties in respect to coins was added the constant tampering of Congress with the national coinage system; hardly any five-year period in our history has been without some modification of the coinage by Congress. Since both paper money and metallic coins were unstandardized, the ordinary risks of business enterprises were increased.

What a handicap this situation in respect to bank notes and coins was to incipient manufacturers is readily recognizable. All manufacturing for sale to unknown customers is more or less speculative, but insecure currency made it hazardous in the extreme. Furthermore, since some unscrupulous employers fleeced their laborers by passing to them at face value bank notes known to be depreciated, outlawed or counterfeited, the condition of the currency was responsible for labor revolts. Labor's animosity to "Wall Street" has a historical basis.

The discovery of gold in California in 1848 soon made itself felt in the marts of trade. It introduced another factor of speculation and a cause of fluctuations in prices. On the other hand,

it opened new markets and acted as a heady tonic to all productive enterprises.

Since the Civil War.—Despite the growth of manufacturing prior to 1860, it cannot be said that the United States got fully into action its potential powers for manufacturing until after the Civil War. Since that conflict we have come to realize what a wealth of resources we have upon which to support manufactures. Indeed, we have unearthed many new resources.

Manufacturing Resources.—Just as forest and iron mines were the bases of the little manufacturing America could boast under colonial dominion so, too, the astounding wealth of natural resources of the continent as a whole is the basic fact behind the phenomenal development in manufacturing that has occurred since the Civil War.

First in importance as a source of supplies for factories are our farms, from which are drawn more than three-fourths of all the materials upon which factories expend their energies. Our preeminence in farms and farm stuffs helps to explain our enviable standing in manufactures. Next to the farms stand our mineral resources, more bountiful and diversified than those possessed by any other nation. Our manufacturing would be solidly buttressed between our metals and our mineral fuels, even if all other mineral resources were omitted. Forests, the resource that furnished us our first manufactured exports, have continued to furnish valuable support to expanding manufactures. In percentage of land area forested the United States leads the world, although in acreage of forest land it is surpassed by Russia, the British Empire and Brazil. In acreage of commercial timber, however, we have no rival.

Of all the resources necessary for a command of manufactures, the outstanding ones in which the United States is deficient are rubber, sugar, linen-flax, silk, hemp, tin and a few rarer minerals, and certain tropical species of wood. Of the long list of resources we do have, we are the world's leader in an astonishing number. With such an exceptional foundation it is slight wonder that our manufacturing has leapt to the world's front ranks. Yet the

abundant resources are by no means the sole explanation of the rapid rise of our manufactures since the Civil War.

Improved Transportation.—Before 1860 our railroads barely reached the Mississippi River, but since then, transcontinental lines have been built. The great Middle West, too, has added road after road until that section has as dense a railway net as can be found in an equal area anywhere. The eastern states have not been behind in building feeders to the trunk lines, or developing interurban transportation. Hence, a whole continent has been spread before our manufacturers; every part of the nation has been made accessible to a factory, no matter where the factory was situated.

Domestic Market.—Since 1860, therefore, the words “domestic market” have included every part of the United States, and the size and extent of the country has made this market without a peer. The mere size of the United States has insured variety in population, differences of climate, unlikeness of resources, and divergences in the stages of economic development. Every one of these things has stimulated manufacturing, for the variety of peoples has called for a variety of products to fill their needs; differences of climate have demanded different sorts of provision for clothes, food and shelter created by different factories; unlikeness of resource has assured unlikeness of occupation, hence giving a basis for trade; and divergencies in stages of economic development have meant that the more advanced must supply the wants of the less advanced. Railroads with unrestricted interstate commerce over a wide area have brought about this condition so favorable to manufacturing. To carry our domestic commerce in 1926 our railroads loaded a million freight cars per week.

Effects of Domestic Market.—A domestic market more than twice as large as that of the next largest industrial nation has been enhanced still further by the extraordinary buying power of American citizens. Always faced with a relative scarcity of labor, the people of the United States have been avid users of machinery; rarely here has the introduction of machinery been seriously

hindered; rather the reverse has been true. By the methods of 1790 the manufactured product of 1927 would have required a population of 3 billion people to produce the volume of goods. But each one of the 9 million factory wage earners in 1927 was aided by 73 iron slaves in the form of mechanical horsepower. This fact, together with a pioneer inheritance favoring strenuous endeavor, has made American workers more productive per man than is the case in other countries. The large output per man has lessened costs of production and enabled the payment of high wages. Soundly founded, thus, the American standard of living has been unusually high. This means that our manufacturers have been assured of a large home market financially capable of absorbing masses of goods, even though the articles ordinarily be deemed luxuries.

This situation has been responsible for the most noteworthy feature of American manufacturing, namely, its mass output of standardized commodities. Mass production within limits and under careful management means low costs. With large-scale output standardization becomes practicable and cuts the costs of production. Whether it be collars or radios, mass production of standardized units runs through all our manufacturing. In the industries that have applied these principles America stands without an equal. For example, the British Crown Prince and even the British Government bought and used American typewriters until the enraged British typewriter manufacturers compelled them to favor British machines. Likewise, American moving pictures, turned out by mass production for an enormous home market, brushed aside the films of foreign producers in their own countries—to the consternation of the foreign governments.

A great country with a common language gives unusual opportunity for advertising. Our business men have not been slow to seize this advantage and it, in turn, has reacted upon the success of plants by bringing a flood of orders to those that captured the public's good-will. National advertising has been no mean influence in establishing American manufacturing upon a solid basis of prosperity, and, of course, it has promoted mass production of standardized articles.

Corporate Form of Organization.—Accompanying mass standardized output the large-scale corporate form of business organization has become dominant. The corporation, with its ability to draw large amounts of capital from widespread sources by division of capital into small transferable shares, tapped the great reservoir of American wealth. For example, the United States Steel Corporation in 1927 had 150,000 stockholders, the Standard Oil Company of New Jersey had 80,000 and the General Motors Corporation had 51,000. Each of these corporations had assets of a billion dollars or more. Once started, corporations themselves become one of the greatest sources of wealth. They build out of their own earnings. Witness the manner in which the original investments in the Gillette Razor Company or the Ford Motor Company have been magnified by earnings. In respect, also, to their limited liability features corporations are better equipped to meet modern business conditions than the older joint stock association, partnership or proprietorship. Perpetual life and legal personality add to the advantages of the corporate form. Their ability to hire experts for every need is another special attribute that places them beyond the competition of less advanced types of organization. We need cite only the millions spent in the experimental laboratories of the General Electric or General Motors Corporation to drive home this point.

Financial Stability.—Perhaps the hardest political battles after the nation was reunited at Appomattox have been those concerned with the stabilization of the American monetary system. Inheriting from Hamilton a double money standard, we struggled for a century with its evils. Our troubles with a double standard began as early as 1795 and lasted until 1900. Bimetallism became an acute political, economic and commercial problem in the early seventies and for nearly a generation divided the country into hostile camps. In the earlier years the silver advocates gained their way but the country's business was prostrated by panics. Defeat of William Jennings Bryan in his "Free Silver" campaign, in 1896 and again four years later, together with the overshadowing of the money issue by the Spanish American

War, led to the adoption of a single gold standard for our currency.

Because of dubious constitutional authority there were no federal bills of credit in circulation in the United States from 1789 to 1862. In the emergency of the Civil War and in lieu of adequate taxation Congress authorized three issues of United States notes, popularly dubbed "greenbacks." Congress intended originally to retire and cancel these notes as soon as possible, but these good intentions were thwarted by political pressure from people who profited by the inflation of the currency which the greenbacks produced. It was not until 1879 that greenbacks passed at their face value.

In connection with the financing of the Civil War, Congress, in 1863, created the National Bank System. By reason of a discriminatory tax on notes issued by private and state banks, a virtual monopoly in issuing notes was assured to the national banks. This wiped out a note evil of long standing, and gave the country a standard national paper money, carefully safeguarded and uniformly valuable.

Although our National Bank System served admirably most of the time after its inception, it had several grave defects. To overcome its faults Congress, in 1914, provided the Federal Reserve System. This system, together with the stabilization of national currency, has produced a confidence and security in our financial structure that has been of immeasurable aid not only to our manufacturers but to all business men and all citizens.

Credit.—Along with financial stability the last generation has witnessed an extensive use of credit, and the expansion of credit instruments. Comparatively little business is conducted on a cash basis; hence, confidence and faithfulness in credit matters are vital to business prosperity. Without credit much of our complicated industrial organization could not exist. It is the breakdown of credit that precipitates financial crises. Credit supplements and multiplies the utilities of currency. Pieces of paper having no tangible value in themselves pass from hand to hand in the process of exchanging goods or services. Since the Civil War we have added to the varieties of such pieces of paper and have taught the

public to value, safeguard, and use them. In so doing, manufacturing and all other business has been helped toward new records.

Tariff Protection.—Another influence at work since 1860 to promote manufactures, an influence ranking in some minds with that of resources, railroads, or financial stability, is the tariff. Since the Civil War we have had an abnormally high rate of import duties and this undoubtedly has called into existence, or protected in their infancy, many manufacturing industries. Well-versed manufacturers, however, claim that a tariff makes little difference to them whether it be high or low, so long as it is permanent. Our actual tariff history with its frequent fluctuations, therefore, is said to have been principally influential in promoting instability of industry.

Because the World War left the United States the chief creditor nation of the world, the tariff policy suited to our former debtor condition agrees poorly with our changed status. Those who owe us can repay their debt in part by sending us money or our own securities, but the major repayment finally must be in goods. As the currencies of our debtors are stabilized it will become more difficult for them to sell us goods over our tariff wall. If debts due us are to be paid there will have to be a modification of our tariff policy.

Moreover, our manufacturers are seeking foreign markets to dispose of their surplus goods, for our productive capacity has at last outrun our consumption. While the average of our exports is 7% of our manufactures taken as a whole, the percentage is much higher in individual industries. The value of our exports of finished manufactures is about 2 billion dollars per year which, allowing for changes in prices, is about double the value of this class of exports before the World War. The increase is largely due to our increased export of machinery and vehicles. Customers will not buy from us readily unless they can sell to us. Of course, if they are forced to purchase our wares there are roundabout methods of affecting exchange, but in general our tariff has about the same effect on trade as the British Navigation Acts had on the trade of colonial New England. For example, our automobile manufacturers would like to sell more cars to

Argentina but our Latin friends cannot purchase them because our tariff shuts out their meat and wool. When they do buy our cars it is with credits from Europeans who obtain Argentinian products. If our trade with Argentina were direct more of our cars would find a market there. So with other countries and manufactures. In so far as these matters influence our manufacturers just so great will be the agitation for a recanvass of our tariff policy.

First Generation.—Almost as important as any factor in accounting for the success of American manufacturing is the fact that the directing officers are still, in most instances, the men who established the business. A concern in the first generation has a greater chance to succeed than one that has been held in a family for some time. Since the founder of a business gives it a full share of his energy, his time, and his intellect, the chance of success is increased, but inasmuch as the man who inherits a going concern often has acquired interests outside of it, or in any case cannot share in the joy or pride of its creation, the business suffers. Heredity also plays strange pranks. There is no guaranty that a successful father will have a successful son, because the boy may inherit, say, his mother's artistic instincts rather than his father's business acumen or, if both father and mother are the business type, the son may revert to a previous ancestor whose abilities turned entirely in another direction. So there is always a great risk when a concern passes from the control of the man or men who made it. The fact, then, that our American enterprises have been in the hands of the men who brought them into existence has been a decidedly strong influence in their favor. One of the principal advantages derived from this first-generation aspect of our business is the freedom with which experimentation has been conducted. Our business men have not been shackled by tradition; as they themselves were pioneers, they were not afraid to try new things. This willingness to learn and change has kept business plastic and hence permitted its growth. New methods, machines, or products have had a strong appeal to Americans because they were a new people in a new country.

Modern Progress.—The years since the Civil War have witnessed a marked change, therefore, in American manufacturing. The betterment of transportation, the size of the domestic market, financial stability, the value of tariff protection, and the freedom from tradition—all these have acted together to put manufacturing into a leading place among American industries. A comparison between the United States and the rest of the world before the Civil War would have portrayed American manufactures in a sorry plight, but a contrast today would show the United States as the leading manufacturing nation of the world. This is not often appreciated because we manufacture largely for ourselves, whereas other nations make a greater proportion of their goods for export. But reliance upon the home market in America cannot longer suffice. We have begun to reach out for foreign markets, an effort that marks the start of a new era in the history of our manufacturing.

CHAPTER VI

LOCALIZATION AND DECENTRALIZATION OF INDUSTRY

Localization—A Passing Phase

Introduction.—"Pill Alley" was the undignified nickname for an otherwise stately, elm-arched avenue in an old college town, the sobriquet finding favor because nearly all the doctors of the community lived side by side upon that thoroughfare. "Pill Alley" is not an isolated example of the fact that professions or businesses, like birds, tend to flock together. Dentists, as a rule, hive in one office building, opticians open their neat shops along the same thoroughfare, department stores crowd about some one vantage point, the warehouses of wholesale leather dealers jostle each other, and wholesale wool merchants congregate near a common market-place. Even commercialized vice has its own "districts."

Manufacturers, too, show the same tendency toward neighborliness. From ammunition to zinc the list of American manufactures yields a startling number of illustrations of concentration of single types of manufacturing within narrow geographic areas. Apparently a business would be most assured of success where it had least competition in the immediate vicinity, but in reality industry thrives best where it throngs most. It is worth while, then, to find out how localization starts and grows, and what advantages it offers.

Raw Material.—The location of raw materials has been potent in giving rise to localization of the manufactures which use those materials. For example, Chesapeake Bay is the greatest oyster field in America, with the result that Baltimore does more than two-thirds of the oyster-canning business of the United States. One might generalize and say that, as a rule, the preserv-

ing industries are located near the sources of their materials. This explains the Columbia River and Alaskan salmon canneries, the former wine plants of California, the grape juice factories of Northeast Pennsylvania and Westfield, New York, the sweet corn canneries of Maine, the tomato canneries of New Jersey, the slaughter-houses of Chicago, and the cheese factories of Wisconsin.

Not only perishable raw materials but also those that are bulky, heavy, or fragile, tend to attract factories near the point where the materials originate. Wooden vehicles once were made near the forest along the Merrimac River; later, with the exhaustion of New England lumber, the vehicle business moved to the Lake States and is now important in Tennessee, close to the Appalachian forests. Likewise, the fragile yet heavy tobacco leaf is manufactured into cigars, cigarettes and "plug" in North Carolina, Maryland, and Virginia, adjacent to the tobacco plantations. Flour mills always have snuggled closely to the largest wheat fields. The rolls, which Franklin's "Autobiography" has made famous, were baked from flour milled at Wilmington, Delaware, then the flour center. The bread served at the White House when Jackson was President was made from flour that probably came from Oswego or Rochester, while Roosevelt's Rough Riders gnawed army biscuits made of Minneapolis flour. The next White House cook book may specify St. Louis flour. In like manner, the makers of soap have clung to the region of slaughter-houses, from which most of the raw materials for soap are obtained. "Ivory" soap, manufactured on the outskirts of Cincinnati, is a reminder of Cincinnati's former greatness as a slaughtering center, while "Fairy" soap is made in the midst of Chicago's stockyards.

Continued Concentration.—Industries called to particular places by resources in materials often have remained where they started long after the local supply of crude stock has disappeared. Among the novel products carried home to Boston, Providence, and New Haven by the far-roving Yankee sailing vessels was Amazon rubber. Experiment with this raw material gave rise to rubber-using industries in or near all three of these cities, the

goods made ranging from overshoes to fountain pens. Although crude rubber is seldom seen today on the docks of these maritime cities, a large proportion of the rubber overshoes, boots, or arctics made in the United States are produced in their locality. A half-dozen plants, most of them belonging to the United States Rubber Company and the factory that turns out Waterman Fountain Pens, are all in the narrow Naugatuck Valley adjacent to New Haven, while that city has rubber factories of its own. There are many rubber plants within hailing distance of Providence, while Boston is girdled with them. Similarly, the plated jewelry industry is centered in or near Attleboro, Massachusetts, just outside of Providence, Rhode Island, because gold and silver from Spain, Portugal and the West Indies once were borne into Providence by home-bound commerce carriers. Bridgeport, New Haven and Hartford have become world famous for rifles and revolvers, an industry long established there because at the opening of the 19th century western Connecticut produced a grade of local iron that was peculiarly adapted to making weapons or edge tools. Grand Rapids is associated with furniture in the minds of brides, although the timber resource that originally gave rise to the manufacture of tables, chairs, buffets and beds long since waned. The present-day greatness of these industries overshadows the circumstance that they came to the regions originally because raw materials were easily secured at those points.

Water Power.—Water power is a resource that has drawn many industries into compact units around desirable sites. One-third of the knit underwear made in the United States is furnished by the towns in the Mohawk Valley near Cohoes, New York, because the first power knitting machines were operated by the large water power resource available there. American writing paper manufacture centered at Holyoke, Massachusetts, where the Connecticut River furnished the greatest water power site in New England. The falls and canal systems at Holyoke also caused local engineers to enter the field of power machinery manufacture, so that later when Niagara was bridled, the great turbines that first turned Niagara's energy into electricity were made at Holyoke. At Niagara itself cheap hydroelectric power attracted the

manufacturers of aluminum and calcium carbide. The large number of rapids and falls in the Merrimac River drew to its banks the largest cotton mill in the world at Manchester, New Hampshire, the largest woollen mill in the world at Lawrence, and one of the principal cotton manufacturing cities of the United States at Lowell; no other stream in the world turns so many textile spindles as the Merrimac. The abundant water power of New York, New Hampshire and Maine were a focus for the manufacturers of wood pulp for paper. Water power, then, as well as raw materials, is responsible for the origin of many localized industries.

A similar situation has existed in respect to coal or natural gas as sources of power. The greatest manufacturing states are those nearest to coal mines and those manufactures in which cost of power is a sizable item cluster about the coal fields. The eminence of Pennsylvania and Ohio in iron and steel manufacture is due partly to the coal resources of those states. Natural gas is the stepmother of the glass industry.

Labor Supply.—An unused labor supply also acts as a magnet in attracting mills to a common point. Wherever an industry has collected a large working force of men, a situation is created favorable to industries using female labor.

Laboring men have sizable families; if no employment is open to young women the household may be financially handicapped by dependence upon one pay envelope. When into a predominantly masculine industrial community there is introduced a factory offering jobs to girls, the fathers and daughters both welcome it. The community becomes more attractive to new families seeking residence and work, while all the local retail businesses feel the stimulus of the greater total income of the population. The new enterprise supplements the old established one and enables the primary industry to obtain masculine recruits by the added inducement of jobs available in the town for the young women relatives of the men. Balanced male and female employment is desirable on economic and social grounds. Wherever it is unbalanced the opportunity is open for the types of manufacture with opposite employment demands.

Originally Troy, New York, was an iron manufacturing city

with jobs open only to men until the collar, cuff and shirt industry gave opportunities to women. Allentown, Pennsylvania, once specialized in cement manufacture employing men and did not become balanced until silk mills invaded it. A like situation prevailed in the anthracite towns, particularly Scranton, where again silk manufacture eventually struck a balance in employment. As a result, Pennsylvania rivals New Jersey in silk production. In the latter state, Paterson, once famed for its locomotives, attained early leadership in the silk industry for reasons identical with those cited. The Amoskeag Manufacturing Company of Manchester, New Hampshire, owner of the largest cotton mill in America, once manufactured locomotives and still makes machinery. The corset manufactures of Bridgeport and New Haven, Connecticut, supplement the employment long offered in those cities to machinists. Wherever employment is lopsided in favor of one sex, there is a tendency to attract industries employing the other sex. In the instances of Troy and Paterson, the female employments that began as complementaries achieved dominance.

Proximity of Market.—The proximity of market always has been a vital consideration in the location and localization of industry. A study by decades of the centers of area, population and manufactures reveals strikingly the influence of market in determining where manufacturing shall be done. Between 1850 and 1920 the center of population moved steadily westward from a point near Parkersburg, West Virginia, across Ohio to a point near the southwestern boundary of Indiana. During the same years the center of manufacturing progressed from the neighborhood of Mifflington, Pennsylvania, northwestward across Pennsylvania and Ohio and, in 1920, rested near Rushsylvania, Logan County, Ohio. The center of population continuously has been east of the center of area—it was 647 miles east of it in 1920—while the center of manufacture has been from 300 to 500 miles north and east of the center of population. That is, as people moved westward factories followed behind them, in the manner and for the function of an army supply train.

Although the pull of the market has influenced the location of all manufacturing, the magnetic effect of the market has been

impressive in certain industries and has affected their localization. A case in point is the manufacture of agricultural tools and machinery. In the rush of planting or harvest, farmers cannot wait for repair parts to be sent from distant factories, and, moreover, agricultural machinery is expensive to ship. Accordingly, the railroad journey is cut to a minimum by placing the agricultural machinery mills near the fields. Once the industry was localized along the Atlantic; then it migrated with farmers to interior New York; later it became centered at Chicago, where there was easy access to all the great agricultural states of the upper Mississippi Valley. As farmers are also the most numerous purchasers of automobiles, the Detroit localization of the automobile business is advantageous in reaching its main market. Cotton textile machinery is manufactured in New England because that section long led in cotton manufacture. Steel manufacturers, being the greatest consumers of coke, determine the localization of modern by-product coke ovens.

Topography.—In New England where there are scores of instances of localization, topography seems to have had a controlling influence. Since most of the early mills were attracted to water power sites, the manufacturing industries clung to stream valleys. These same valleys, with a general north-south trend, were usually the arteries of communication; travel overland east or west was arduous. Valleys near each other geographically often were remote socially for the reason that communication was checked by steep hill roads. Consequently, an industry started in one valley might spread rapidly up or down that valley, yet be unknown or untried in another only a few miles away. The Blackstone valley concentrated on textiles, the Quinnebaug on edge tools, the upper Connecticut on paper, the lower Connecticut (geologically) from Hartford to New Haven on hardware, the Naugatuck on brass. In southern California the variety of topography was one of several factors favoring the localization of the "movies" near Los Angeles. Topography then must be included among the various causes that have given rise to the localization of industry.

Chance.—But more than resources, labor, markets or topography, more than any other reason for the start of localized industry, we must recognize the force of chance. Westfield, Massachusetts, manufactured over two-thirds of the nation's whips because one irate farmer incensed by his neighbors' pillage of his willow hedge to belabor their horses, cut the willows himself, bound them with twine, and sold them to the erstwhile plunderers. That started an industry which later made the town conspicuous. The position of Lynn in the shoe industry, the center of a circle of towns manufacturing a fourth of the shoes worn in the United States, is partly due to the chance settlement there of a Welchman named Dagys, the most skillful shoemaker in the colonies. Germans from the Palatinate, skilled in the art of knitting, fleeing to America, found congenial religious refuge in Penn's settlement of Philadelphia. Once established on our soil they set about their accustomed trades and soon made Germantown (now part of Philadelphia) famous throughout the colonies for its stockings. As a result, Philadelphia has manufactured more hosiery than any other place in the country. A survey of all the instances of localization would prove that accident has been the most influential factor in determining where a localized industry would start.

Monopoly.—However, mention must be made of the pseudo-localization sometimes produced by monopoly. In modern industry we are familiar with the spectacle of one corporation or group of allied companies gaining such ascendancy over the whole trade that arbitrary decisions replace the usual give-and-take of competition. It is obvious that such a monopolistic control may choose the most desirable locations for its plants in order to concentrate its efforts in the most advantageous places. The limitation upon the number of factories and the large output in a few selected towns or cities bear a close resemblance to the localization of industry.

For instance, practically all of the oil-refining done in America is carried on in a half-dozen plants, some on the Atlantic coast, some in the Central West, and some along the Pacific. Similarly, sugar-refining is confined to a few strategic points. The manu-

facture of shoe machinery likewise is principally in one town, Beverly, Massachusetts, in the heart of the greatest shoe-making district. In these cases, the localization is artificial and could be annihilated by an adverse court decision or the expiration of patents. Before the Standard Oil Company gained its supremacy there was no localization of refineries; the American Sugar Refining Company is responsible for the localization of its industry; and if there were no United Shoe Machinery Company every machine tool center in the United States would have the possibility of producing shoe-making machinery.

And while without monopoly it is doubtful if localization would have occurred, once it has been established it is likely that a degree of localization would endure even if the motivating monopoly disappeared. In Europe, it may be remarked, many of the localizations date from the days of guilds in the 11th to 16th centuries. These guilds had monopoly privileges, one of which was the limitation of certain industries to particular guild districts. Having gained an early start some of these original monopoly centers have been continued despite the ban on the original monopoly.

Family Control.—Whatever was the cause of their inception, all localized industries have shown similar methods of growth, have profited by like advantages, and have suffered by reason of analogous handicaps.

Many industries became localized because they were family affairs. A father in business with several sons established those sons in branch plants or associated lines which, growing to prominence around the original plant, gave a reputation to the locality for that particular business.

To cite an illustration, the cotton manufacturing industry of southeastern New England was long associated with the names of Slater, Borden, Sprague or Knight, while the cotton manufacturing of the Merrimac River was just as intimately connected with the Lawrence, Lowell and Jackson families. In colonial America an iron-making project was said to be incomplete unless a Leonard was in control, and the great brass industry of western

Connecticut was the outgrowth of the Scoville, Benedict, Burnham and Chase families.

Industrial Family.—Superintendents or foremen may be considered members of an industrial family analogous to the sons and brothers bound by ties of blood. Industrial families have been as influential as real kinsmen in increasing the importance of an industry in a town. When an experienced superintendent decided to become his own boss oftentimes he found that he could succeed best in the shadow of the plant where he was once an employe. In a strange place he was unknown, but in the town where he had worked for years the bankers knew and trusted him and the business he proposed to enter was a tested proposition. It has been stated that every New England cotton mill between 1790 and 1814 was started by men who themselves had been trained by Samuel Slater at Pawtucket, Rhode Island. Growth of this kind, through former workmen, made Trenton the seat of pottery manufacture, and Gloversville the chief center for the manufacture of men's gloves. Ransom E. Olds established the first large automobile factory of America at Detroit because he was aided financially by several retired mining and lumber men residing in that city. Among the young men Olds gathered about him were a dozen or more who afterward built cars of their own. The roll of the early Oldsmobile executives, together with the man who manufactured parts for this first successful car, is almost a complete roster of the most famous automobile manufacturers. Most of them erected their factories in Detroit close to Olds' original works.

Local Investment.—The timidity of local capitalists is another cause for an industry's expansion in a particular place. Many men with small amounts of money are afraid to risk their funds in any project unless they can keep it under daily observation, but they encourage new ventures in their own town as long as there is promise of profit. Previous to 1839 Salem had been one of the greatest of our seaports but in the next 20 years it lost its shipping to the larger neighboring port of Boston. Salem merchants who had acquired fortunes refused to move from their

native city. Instead, they retired from the sea and invested their funds in an experimental cotton factory, daring to operate it by steam rather than by the traditional water power which Salem lacked. Thus started, the Naumkeag Steam Cotton Company became nationally notable for its "Pequot" sheeting, a product it has manufactured continuously for almost a century. At a later date, New Bedford whaling captains saw their own business declining while they witnessed the great strides that their close neighbor, Fall River, was making in cotton manufacture. But the old whalers balked at furthering enterprises in another town. Instead, they put their money into cotton factories in New Bedford itself. Sustained growth from this start gave New Bedford the enviable reputation of standing at the head of the cotton industry both for quantity and quality of output.

Division of Manufacture.—Sons, superintendents or local capitalists promote the early growth of an industrial center, but the mature advance is occasioned by the multiplication of allied industries, the increase in the number of supply houses, or the presence of plants utilizing wastes.

Instead of attempting to manufacture an entire shoe, many plants in Lynn or Brockton confine themselves to making heels, counters, box toes or soles; similarly, in Lowell, New Bedford, Philadelphia and other textile centers there are enterprises that specialize in originating patterns or designs, others which prepare warps for looms, and yet others that produce spools or cops to hold yarns. The greatest source of automobile accessories is Detroit, which is also the largest producer of automobiles. Philadelphia, one of the chief textile centers of the United States, has more dye-houses than any other city. About two-thirds of the needles and pins of American manufacture come from Connecticut, the state that supplies the brass of which needles and pins are made. The brass hardware industry—door knobs, latches, hinges, screws, locks, stops and checks—is a near neighbor in Connecticut to the brass casting and rolling-mills. In like manner, movie accessory businesses steadily invade Hollywood, California.

The close union of independent and dependent mills is a striking feature of our manufacturing industry. Accessory or parts

manufacturers would meet with less success if they attempted to produce anywhere but in a community where the main industry was localized, because the expense of reaching a market would exhaust profits. On the other hand, the presence of shops specializing in parts of the main product aids the larger factories, for it enables them to purchase supplies right at hand. Partly finished material is produced at the very doors of the factory that will complete it for market; hence, transportation charges are reduced and annoying delays in delivery obviated. Large and small enterprises benefit each other because by subdivision of product and by greater specialization the costs of production are so reduced that outside competition is easily met. Consequently, an industry once thoroughly established in a locality grows by what might be called cellular accretion.

Waste Materials.—Localization, furthermore, attracts plants whose business is the utilization of waste products. In order to ensure a plentiful supply of raw material these shops must be where there are many factories creating the same sort of waste. While waste created by processes of manufacture must not be confused with materials worn by use, the latter, too, are reclaimed, and the manufacturer who does the work may locate near those who supplement fresh crude stock with reworked materials. Here we are concerned with wastes produced in manufacturing. An instance of the economy in utilizing wastes may be witnessed in the cement plants, some of which fasten upon the edges of steel districts. Cement may be manufactured from slag, the scum of impurities, which are taken from the ore when iron is smelted and which ordinarily had no value. It happens, however, that slag usually contains the materials that compose cement. A cement plant corollary to a steel works, therefore, rids the premises of the accumulation of slag and, at the same time, turns what would be a cost into a revenue-producer. Another illustration of the utilization of waste is seen in New York City, the nation's tailor shop. The short ends of cloth are purchased by adjoining cap shops, an arrangement that is advantageous to cap-makers, because it saves a cutting and allows a wider range of cloth patterns than the manufacturer could afford if cloth were purchased in the whole

piece. Again, at the city of Gloucester, Massachusetts, one of the world's most famous fishing ports, the heads and tails of cleaned fish are carried by the dray load to a factory that is famous as a producer of glue and mucilage. Waterbury, Connecticut, also, around which city half of America's brass is made, has a "brass laundry" where small pieces of scrap and shavings are washed to recover the machine-shop oil, to separate brass from other metals, and to make the recovered brass available as raw material for recasting. In the textile industry many factories specialize in producing yarn from fibers of a specific length. The shorter fibers combed out become raw material for another factory nearby concentrating upon short fiber yarns. This progression may be repeated several times until the final waste is lint so small that it will float in the air. Even this may be collected and used for raw materials in factories producing lint products or combining the lint with other materials.

Wherever such waste-using plants appear, they add an increment to the importance of a locality as the center of an industry and augment the growth of the industry in the location where it is already rooted.

Prestige.—After a town has become thoroughly identified with an industry its name has such an advertising value that new concerns seek it instinctively in order that the prestige of the place may bolster their own reputation. Detroit is the Mecca for incipient automobile manufactures, the name "Brockton" lends quality to a shoe, and New Bedford stands for high-quality cotton. A clothing label bearing the charmed address "Fifth Avenue, New York City" recommends the clothes to persons who do not know that Fifth Avenue like Caesar's Gaul is divided into three parts.

Skilled Labor.—One of the principal outstanding facts in regard to localized industries is that, almost without exception, they depend upon highly skilled labor, a circumstance that helps to account for their paradoxical prosperity. An adequate supply of especially trained labor is the foremost advantage enjoyed by the individual units that comprise a localized industry. If one plant desires to expand it can draw upon the reservoir of labor

already created. All the factories in the town constantly are filling this reservoir because each mill is a training school for the others. The young boys upon leaving school follow in the steps of their fathers, learning by actual experience in the factory the moves peculiar to the particular industry, and at home, on the streets, or at recreation imbibing the secret "rules-of-thumb" current among workmen and known only to them. The very atmosphere seems charged with a mysterious power drawn upon by the men to further the efficiency of their labor, a force which is lost in a city whose industries are largely diversified. The whole accumulation of skill is at the beck of the firm which needs it, and in an industry where trained men are required its value is beyond estimate.

Inasmuch as trade secrets and tricks of manipulation of material are handed down from father to son and from friend to friend, there is a social heredity of skill transmitted from generation to generation. Newcomers are easily absorbed in the all-enveloping trade in its home place. On the other hand, manufacturers who have attempted to draw away even the most highly trained individuals to act as teachers in another remote city repeatedly have met with failure because the *group* was not skilled and had not known the trade from childhood. The group skill found in localized industry is the reason why the industry clings to one small section of the country; it is the greatest single advantage that employers find when they set up their plants where others have thrived for years.

For example, the greatest resource that the Commonwealth of Massachusetts possesses is her abundant supply of skilled men and women collected in various localities where special work is being performed. The contrast with a state like Pennsylvania is made plain if we suppose some awful catastrophe to sweep away all the people of both states. After such a calamity Pennsylvania would at once arise again in power because her coal, natural gas, iron and agricultural sections—such as Lancaster County, famous for its farms—would bring a new population to work these natural resources; but Massachusetts would be dealt a blow from which she might never recover. Skilled labor, then, is a basis for industrial wealth, and this resource is nursed and conserved by localized industries.

Mobility of Labor.—Skilled labor differs radically from unskilled in its mobility. Skilled men and women dislike to be wrenched from the town where they have settled. They have made many social or economic ties that are hard to break; their friends and relatives live in the town, their fathers and mothers perhaps are buried there, they own their homes there, and have other small investments, perhaps in land, perhaps in the industries of the town. Since so many localized industries employ skilled laborers, they perforce must stay where the labor has become knitted to the locality. On the other hand, unskilled labor has no deep roots in the soil of a place; its interest is primarily financial—the pay envelope—and not social. Hence, unskilled labor may be shifted from town to town with the utmost ease. This helps to explain why industries employing unskilled labor are not localized, while skilled industries are highly concentrated in particular communities.

Home Work.—The visible supply of labor at work in the factories is not the only advantage a localized industry offers to mill-owners, for there is a less apparent benefit which grows out of localization in the ready, rapid expansion of the labor force during rush seasons by means of home work. We talk about our times as the “factory era,” yet one-half of the people¹ employed in producing wearing apparel, jewelry, silverware, paper articles, sporting goods and celluloid ware, are never housed within factory walls but do the work in their own rooms. In Massachusetts, for illustration, home work is not confined to large cities, to tenements, or to foreigners, nor is it done for an unofficial pittance by the poverty stricken. The tasks are performed by women about thirty years old, who have formerly been wage-earners, but are married and tied to their homes by children, yet glad to do little jobs to earn “pin money,” perhaps as little as \$100 a year. Manufacturers are delighted to avail themselves of this labor force, for it makes no extra demands on the employers and yet enables them to get out orders on time. It is their safety valve—or, to use economic terms, the “marginal element in the

¹ Massachusetts Bureau of Statistics, *Industrial Home Work in Massachusetts* (Labor Bulletin No. 101).

labor force"—since the factory force may be kept intact while the number of operatives outside the walls swells and contracts with the demand for products. In times of special stress, such as a war or an unusual industrial boom, many of the home workers can be brought back to the factory. Widows and women whose children are grown often return to the factory they left upon marriage. Nor is the harsh compulsion to self-support the universal motive that induces them to recover jobs they long since forsook. Companionship and the creative impulse are also incentives.

When the nature of the home work necessitates some skill or previous training and when, at the same time the product is subject to the whims of fashion or to seasonal variations, the manufacturer is well-nigh compelled to locate his plant where the labor lives. This is true of the manufacturers of combs, jewelry, women's neckwear, shoes, gloves and collars, to mention only a few of the many illustrations. Hence, in localized industries we must add the invisible trained labor force to that which is in plain sight in the factories; the two together form a combination whose advantage no employer can overlook.

Buying and Selling.—In a localized industry small concerns may buy together and thus gain the advantage of bulk shipments, a saving which in the course of a year would represent a considerable amount. Freight rates are apt to be lower, too, where there are many concerns purchasing the same sort of raw material, because the railroad will equip itself to handle the variety of freight in which its customers deal. By cooperation, the cotton manufacturers of New England have been able to secure such low commodity rates on cotton shipments that whereas formerly much of their raw material was shipped to them by water it now comes almost entirely by railroad.

In selling it is easier to dispose of wares in the vicinity of others who are doing the same thing because a market is established to which prospective buyers come. This is the reason doctors, dentists and department stores locate where there are other doctors, dentists and department stores. A new concern cannot afford to forsake the involuntary aid extended by its neighbors in the same business. Together they constitute a center which pur-

chasers seek ; separated, each concern would be forced to put forth strenuous efforts to attract buyers to its doors.

Concentrated Market.—The creation of a market within a localized industry leads logically to the result that some portion of the community devotes itself more and more exclusively to the marketing side of the business. In England, Manchester is less a cotton-mill town than it is a warehouse city where raw materials are collected for the cotton mills in nearby Bolton or Oldham, or where the cloth from those mills is sold. Leeds holds a similar position in respect to the iron trade of England. In Massachusetts we see a like tendency in that Boston is the warehouse for the shoe industry on its border, and New Bedford is really three towns under one name, two devoted to manufacture and one to trade. Worcester holds an analogous position for the textile mills of the Blackstone River Valley, and Providence for the jewelry industry of the Attleboros. New York City is notable for the increase of its marketing function and the relative decrease of its manufacturing. What Brooklyn, the Jersey shore towns and nearby Connecticut cities are to New York so, too, the cities of Oakland, Berkeley, Richmond and Alameda are becoming to San Francisco. The outlying places house the manufactures while the metropolis functions as a market and financial center for the peripheral factories.

The cause for this striking segregation of the market is twofold ; on the one hand, it is due to unusual transportation and financial facilities at one part of the district and, upon the other, to the increasing rents at a center, driving factories to the rim and leaving the heart to offices which take up little space. These central places, too, offer advantages for buyers to congregate ; aside from railway or hotel accommodations, it is easier for buyers to visit a series of warerooms close together than it is to travel from mill to mill, although the mills may all be in one district. Wherever an industry has become sufficiently developed in one locality to bring forth a central market for buying and selling, the advantages of the localization are greatly increased, since a well-defined place of bargain and sale secures more trade than would a number of scattered offices.

Advantages to Employes.—Not all the advantages of localization are on the side of the employers; the employes also gain by dwelling in a city where there are many factories where men of one trade are employed. For instance, a man who is a cotton-weaver stays where weaving is done in several factories, because if he loses his job in one he may be able to get a place in another. Likewise, immigrants or weavers from other states will seek the town where weaving is a well-known occupation because they have a chance of obtaining employment at the thing they know best. Consequently, in a localized industry there is greater security of jobs for laborers than in a town where there is only one factory of a kind. Furthermore, where there are many people engaged in the same tasks, a labor union is much easier to form than in a community boasting one factory of a particular type, unless that one is exceptionally large. A skilled man or woman fares better in a place where there are many others who possess the same kind of skill, since all can make their demands felt by acting in agreement. Although the organized cotton-mill workers of Fall River constituted but a small fraction of the total number of wage-earners in the industry, nevertheless, for many years they set the wages for the whole group in New England; in concerted action there was strength.

Disadvantages of Localization.—To both employer and employe, therefore, localization offers many advantages, but it also has deterrent features that detract from the favorable picture we have drawn; there are shadows as well as high lights.

Chief among the disadvantages is the distance separating the industrial center from the consuming market. As we have mentioned before, buyers tend to seek the community in which an industry is localized, but these men represent wholesale houses, jobbers or large mercantile establishments, most of which of necessity must be far from the town where the goods they purchase are produced; consequently, the public to which the wholesale men cater is a long way from the factories. For illustration, products manufactured in New England must be transported often half the breadth of the country before they reach the individuals who actually use them. This long carriage adds to the

cost of the articles to such an extent that an effort is made to produce the things needed nearer the point of consumption. It was for this reason that shoe factories were first set up in St. Louis, and the advantage of being near the market has so fostered the growth of the business there that St. Louis now ranks among the four most important shoe centers in the world.

But for the most part the disadvantage of distance from consumers is easily borne by the localized industries because their products are either small and of light weight, or have such a high value that they can bear long shipment. In every case, the labor charge is a large item in the costs of production, so that if a manufacturer must choose between cheap transportation and cheaper labor cost, he unhesitatingly votes for the labor. To locate near the market but away from the recognized center of skilled labor adds greatly to the payroll, for men can be induced to leave home only by the lure of more money; and, furthermore, transplanted factory operatives lose in group efficiency. As a result, the distance separating producer and consumer, although a disadvantage, is not the greatest of evils when goods are relatively easy to transport.

Distance from Raw Materials.—In like manner, many localized industries are remote from their source of raw material and therefore must face a freight charge upon every unit of stock they use. Here again the actual amounts to be paid are more startling than are the relative costs for the cost of carrying cotton from the South, leather all around the world, steel from Sweden, and rags from Europe, forms so small a portion of the value of the finished article—cloth, shoes, tools, and paper—that the burden on the business is scarcely recognizable. So long as labor represents the largest single item in the total cost of production, localized industries, as a whole, will not be likely to seek a position nearer raw materials in order to save freight charges.

Labor Unions.—From the employer's point of view, the strength of the labor unions in a localized industry sometimes is abhorrent. Labor organizations are strongest in those industries in which the labor force is most highly skilled and collected in the

narrowest area. In the grip of such unions, employers are helpless, when pinched they wriggle, squirm and cry out just like any other weak thing in the grasp of power; their only relief is to run away. The unions of Lynn became so dictatorial in the matters of "closed shops," wages and hours of work, that several shoe firms employing many hands moved outright to Lowell, Manchester and other towns. In these places they gained a temporary relief, but as the towns became shoe centers the union followed, so that in the course of time the manufacturers had to submit to labor or seek a newer asylum. The power of unions in localized industries, therefore, is a strong force working toward decentralization, at least until unions cover the whole industry over the entire nation; then there would be no escape anywhere and one place would be under the same conditions as another.

Competition.—Since competition is most severe where the competitors are closest together, every manufacturer must accept the terms offered by any one of their number, otherwise most buyers would flock to the firm offering the lowest prices. Frequently, in a localized industry the whole trade is demoralized by the presence of some beginner who, although skilled in his work, nevertheless is a poor business man because he cannot calculate costs accurately and consequently bids for business by selling his goods below the actual cost of production. Of course, he meets ruin eventually or changes his policy, but so long as he maintains his low price level all other manufacturers must sacrifice profits in order to conform to it.

Competition is also made a strenuous struggle by the constant strain for improved processes. No matter how carefully guarded the secret of a new device may be or how securely it may be protected by patents, nevertheless in a localized industry such a secret device soon becomes known and every manufacturer installs it in some more or less modified form, with the result that no man can long enjoy exclusively the fruits of his own inventiveness. The study of processes is a daily grind and the race for improvements is swift indeed, yet the prize is barely attained when its value is snatched away by a new race for a new prize. This situation is highly desirable from a social viewpoint, for it tends to

lower prices and widen consumption, but to the manufacturers who bear the brunt of the contests, it is extremely discouraging.

Hard Times.—To the whole population of the district, a localized industry brings another source of dread, particularly if the community has specialized in the industry. To illustrate the distinction between localization and specialization, Philadelphia is a center where carpet manufacture is localized, but Philadelphia has not specialized in that branch of business. Her industries are widely diversified. On the other hand, Trenton is not only a seat of the pottery industry, but the town has specialized in that trade. Little else is manufactured there except pottery. It is that kind of town we have in mind.

In such a town the fear of hard times always hovers over the people. As long as business is prosperous there is hardly a better place in which to live than Attleboro, Massachusetts, for everyone has plenty of money and does not stint the spending; but Attleboro, manufacturing a luxury—jewelry—early feels a fall in the industrial barometer and during a period of business stress there are few places harder hit, or in which people look more anxiously for a return of better conditions. This is true of every town whose industries are subject to an elastic demand and are not diversified.

Blight of Uniformity.—From the point of view of employes, localization is bad because it tends toward narrowing the minds of the townspeople. A young man brought up in Fall River, say, has but little choice of occupation; he must in some way be connected with cotton manufacture. By upbringing, education and example, he is forced into that path and, furthermore, he goes to work at an early age. It may happen that in this way many a life is constricted which might under better conditions have expanded. There is something deadening to the human mind in uniformity; progress comes through variation; therefore, in a town of one industry a young man loses the stimulus for self-advancement. In such a town there is little difference in social position, with the result that young people do not have the force of example prodding them to aspire toward heights above their present station. Dis-

content translated into action may be a blessing in disguise. Contentment tends toward lethargy and the creation of a laboring class that is self-perpetuating, a condition inimical to American ideals.

Balance of Advantage.—On the whole, however, the disadvantages of a localized industry are outweighed by the advantages. The ability to secure the right labor, the ease of selling, and advantages in buying, recommend to an employer the place already established in an industry. On the part of the employes, security of jobs and opportunity for organization among the workers are strong lures toward a center recognized for a particular class of work. Therefore, an industry started by a local resource or by accident continues to grow in one spot through the branching of new plants from old ones, through new concerns organized by sons or superintendents, through the advancement that comes by subdivision of product, and through the accumulation of small factories that make use of waste products. Localization, therefore, has been a persistent feature of industry.

Decentralization—A Modern Phase

Trend Toward Decentralization.—Although persistent, localization is not necessarily permanent. Technological improvements as well as economic and social changes are loosening the bonds that have hobbled manufacturing and are exerting a powerful influence in promoting decentralization of manufactures. Modern industry exhibits a much more marked trend toward decentralization than localization.

Raw Materials.—So far as raw materials have determined localization it has become possible to escape this bondage by the discovery of new areas containing the materials. When this good fortune was lacking it was still possible to throw off the constraints by manipulating the raw materials or finding substitutes for them.

It is obvious that from the start of American industry new sources of raw materials continually have been revealed. The spreading of people westward made known many resources of which the first builders of factories were unaware. So, from the

day of Daniel Boone the constant unveiling of new locations of resources has acted as a decentralizing force in industry. The exhaustion of a local resource often has compelled removal to a newer district.

On the other hand, manipulation of known raw materials has done as much to spread industry as the discovery of new endowed areas. Bulky, heavy, fragile or brittle raw materials may be changed in form so as to bear the costs of shipment for long distances. For example, much has been done with concentration of materials. Concentration for a long time has been a familiar practice in mining. Copper smelters at Anaconda concentrate the copper ore found in Montana and then ship the copper ingots to Connecticut or New Jersey for refining and manufacture. Minnesota iron ore is not shipped "as it runs" from the mines, but is graded upward and then sent to blast furnaces at Duluth, Chicago, Cleveland, Erie, Buffalo and Pittsburgh. In normal times coal, too, is concentrated before shipment from the mines. Borrowing the idea of concentration from the mineral industries, the tanners have freed themselves from a forest location by leeching tannin from the bark of certain trees and carrying the resulting "extract" to convenient collections of hides at packing centers, or to localized centers of leather manufacturers, such as shoe factories.

Canneries ordinarily have been bound to the fields or orchards in which the vegetables or fruits were grown. Cold storage, however, has lengthened the distance and time from tree to can. The new knowledge of vitamins indicates that decay in vegetables and fruits may be arrested by removal of vitamins, thus enabling long distance transportation. Valuable vitamins then may be restored at the cannery. New methods of drying and self-sealing raw materials for canneries have broadened the choices of cannery locations.

If raw materials cannot be manipulated so as to take long journeys without injury sometimes it is possible to find substitute materials.

Pittsburgh's virtual monopoly of Connellsville coke, a product with a limited travelling radius, once gave the Smoky City a

special hold on the iron industry. But of late years coke made in ovens that save the by-products of distillation has enabled the production of a good quality coke from ordinary grades of coal. Iron and steel are now manufactured at Gary, Duluth and Birmingham, far from the famous Connellsville coke, by the substitution of by-product oven coke. Since these cities have other advantages over Pittsburgh in the manufacture of iron or steel, the freedom of location permitted by by-product coke is of economic importance.

In the furniture industry—noticeably in those branches manufacturing office, kitchen and hospital furniture—wood as a raw material has been displaced by steel. The greater accessibility of steel, however, is only a partial reason for the change, for the differential in price must also be taken into account.

Fifty years ago when wood pulp replaced rags as raw material for paper, the paper mills that had been localized near large cities or textile centers were scattered along the edge of forests from Maine to Minnesota.

Skilled Labor.—Greatest of all the influences in the past conducive to localization has been the immobility of skilled labor. But labor's skill is an ephemeral prize. Machinery, subdivision of tasks, multiplication of trades or industries tend to reduce labor to the semi-skilled or merely trained status. Indeed, the very power wielded by labor because of its skill has been a challenge to employers; these diligently have sought methods to offset labor's authority. Transference of skill to perfected machines was one step in the employer's campaign. That the highest types of machines often require the highest types of men to set up, repair and sometimes operate the machines, does not invalidate the argument; for these high-grade mechanics are not only relatively few in number but by the necessary preliminary training—often engineering schools—are quite removed from common allegiance to the labor class. Aside from the installation of automatic or semi-automatic machinery, the employer has continued his campaign against labor's skill by simplification of jobs. While it takes a skilled man to perform a complex task, a man of relatively low caliber may be trained to do one simple

thing. Compare the artist cabinet-maker with the wood-turner who rounds standardized chair legs.

Of great assistance to employers in their struggles against skilled labor has been the modern practice called "scientific management." A thorough installation of scientific management with its motion, time and fatigue studies, together with functionalization, including a planning department, leaves little of the monopoly of skill in the hands of labor.

Except as upspringing new industries, the power of organized labor, and the resistance of inertia delay the movement, the modern industrial trend is away from skilled to semi-skilled labor. Whereas, skilled labor draws factories to itself and so produces localization of industry, the unskilled have no such power but must seek the factory wherever the factory owners choose to put it. As a consequence of the decline in skilled labor the localization based upon it is likely to be of continuously less significance.

Sanitary potteries employing skilled labor are localized; electrical porcelain plants using machinery are scattered. Glass manufacture once dominated by skilled labor and localized has substituted compressed air for lungs, molds for skilled fingers, and conveyors for legs, and has spread across Pennsylvania, Ohio, West Virginia and Indiana. Brass casting, even yet a hereditary secret among selected Connecticut casters, has now been brought under the control of the physical and chemical laboratory in some other places, with Buffalo, not Waterbury, blazing the new scientific methods.

Power and Fuel.—Among other matters that have had a bearing upon where a factory should be built have been the factors of power and fuel. The evolution from localization to decentralization is unusually easy to trace in so far as power or fuel is concerned. When water power was supreme localization was inevitable. With the incoming of the steam engine the choice of location widened, but still freight rates on coal exerted some curb on location. Hydro- and carbo-electricity, together with constant improvements in the transmission of electricity, already have widened the areas where factories may locate without suffering from lack of power. They foreshadow the day when so far as

availability of power is concerned New York City and Death Valley will be equally advantageous places for manufacturing.

Capital.—Although today there are men like the former Salem merchants and New Bedford whaling captains who will not make investments where they cannot keep the enterprise under their own eyes, such men are now of slight account in the canyons of finance where industrial fates are settled. Wall Street and its offspring in other cities are not provincial when making investments. Wherever a manufacturing enterprise gives a reasonable assurance of gain with a minimum risk, capital from the most distant points is ready to support it. Beacon Street's timid old maids furnished part of the capital for the roaring copper camps of Michigan and Montana. Furthermore, capital is not national; in itself it has no patriotism; American dollars crossed the Marne and Rhine with equal facility. The minted eagle is a familiar bird in China, Chile, Canada and the Congo. On the other hand, pounds sterling, francs, marks, and thalers have come to the United States to purchase the securities of companies engaged in transportation, mining and manufacturing. Consequently, men desiring to establish an industrial enterprise do not have to depend upon local capital to support their project.

Transportation: Past Phases.—Interwoven with all of the factors of factory location is the vital matter of transportation. Lack of transportation thoroughly decentralizes industry. The earliest stages of manufacturing in this country, when all industry was of the local type exemplified by sawmills and grist mills, well illustrate how absence of carriage facilities constricts the area of business. The progress of railroad building from 1828 to 1900 was a most essential element in determining manufacturing activities in the United States. Railroad policy was a vital influence in the growth and preeminence of eastern manufacturing.

In order to bind the whole nation together and to encourage the use of railroads in thinly settled regions, it was a necessary part of railroad strategy to fix freight rates at the lowest possible point. As a result, between 1828 and 1916 railroad freight rates were successively revised downward. Furthermore, the rates

were arranged to give precedence to the long haul over the short haul. It was to the interest of the railroads, since they made their profits on the long rather than the short hauls, to keep manufacturing localized in the East where it first developed and to prevent wide decentralization of manufacturing in the western agricultural regions.

Rates were also adjusted so as to give undue favoritism to the large eastern seaboard cities. This led to the building of great centers of population in the East specializing in manufacture and the wide dispersal of agriculture, mining and forestry in the middle and far West. The result was a long haul for manufactured articles westward and a long haul of agricultural, mineral and forest products eastward. The fixing of rates as indicated was a part of a necessary stage in the economic development of the United States and criticism cannot justly be levelled against it. Without such an arrangement it is difficult to see how a continent could have become a nation so quickly.

Present Tendencies Point to Decentralization.—But the period when these things were necessary has passed. The country is now more or less settled from coast to coast. Distinct regional differences in economic development are fading. Although there are many reasons why industrialization cannot be equally complete in all regions, the more nearly we approach regional self-sufficiency the stronger we will be as a nation. Ohio, Illinois and Michigan have attained a balance between extractive and manufacturing industries that approaches closest to the ideal condition.

Among the forces that are compelling a similar balance in industries in other regions, the one with the most pronounced immediate influence has been the sharp rise in railroad rates since the opening of the World War. These increased rates have caused manufacturers to scrutinize their position in relation to markets and raw materials. Out of their studies has come a distinct movement toward decentralization. This does not mean that old locations have been abandoned, but that expansions have been planned for new centers at some point advantageously situated between raw materials and market. These plans have the effect

of spreading industry more evenly throughout the settled parts of the nation rather than concentrating them in the northeast corner.

Nearness to Market.—It has been true at all times that the factory nearest to the market for its product has had advantages over all others at a distance. Intimate acquaintance with the needs of the market, sensitive reaction to the whims of that market, quick response to emergency demands, and lowest carriage charges on goods, all have favored the factory in close contact with consumers of its goods. These advantages have been sacrificed in the past only because they were overshadowed by the necessity to be near raw materials, power or fuel, or because localized skilled labor was vital to production. With the decline in the importance of these factors, the economies of a location in easy touch with the market have been stressed.

For many manufactured wares the market is the nation. Therefore, to keep in touch with the market requires manufacturers either to locate close to the center of population, or to divide the nation into natural districts, each of them served by its own manufacturing plants. Both of these policies tend to decentralize industry.

The division of the nation into districts, each with its own manufacturing, is taking place right now. The oldest manufacturing area, New England, that once served all the nation, has organized a New England Council, one of whose purposes has been to promote sales of New England products within New England. The militantly self-conscious Pacific Coast is valiantly endeavoring to establish its own manufactures so as to shake off dependence upon the East and to relieve itself of high carriage charges upon manufactured articles. Likewise, the aroused South has begun an industrial campaign to balance its extractive industries. The Middle West undertook its own manufactures almost as soon as settlement was assured and has progressed so far that Ohio closely resembles Massachusetts in its degree of manufacturing, but is more fortunate in the possession of extractive industries.

To be sure, no section is completely self-sufficient in its manufacturing; but this fact does not invalidate the tendency in that

direction. Decentralization of manufacturing, therefore, is not only foreshadowed for the future but is a present condition.

There have been attempts to combine large-scale industry and even localized manufacture with decentralization of plants near to the final consumer. The manufacture of Ford cars is a case in point. The principal plant, of course, is at Detroit, but all the large distributing centers have assembling plants of considerable size. These plants also manufacture some small parts and do much repairing on cars already sold. This scheme admits of large scale production of the principal parts of the car at Detroit with cheaper shipment in the knock-down state to the sub-manufacturing units, and then the assembling and final shipment to the consumer from these units.

Although the Ford car is spectacular in this device, it is by no means unique. Similar schemes are practiced in many other trades. Montgomery Ward and Company, the large mail-order house, in addition to its principal warehouse and manufacturing divisions at Chicago has branch houses at St. Paul; Portland, Oregon; Fort Worth, Texas; and Kansas City, Missouri. Furthermore, the large shoe manufacturing concerns of eastern Massachusetts have branch plants in St. Louis and Cincinnati.

Decentralization Favors the Worker.—On the human side it is far more desirable to have a large number of relatively small factories scattered through small cities and towns than it is to have great plants erected in the large cities of the East. The life of an artisan in a large city is often figuratively expressed as machine slavery, and the facts of the life—tenements, scorching grassless pavements, noise, violence, disciplined attendance at work, ceaseless fear of the arbitrary impersonal decisions of employers—do not give the lie to the metaphor. The supposed advantage of the city in supplying amusements is usually overrated. For the city worker, except for the occasional sight of a large parade or the procession following some famous person, dead or alive, diversions are fewer and social amusements much rarer than for the workman who dwells in a smaller place. Amusements, also, are more costly in the city. Swimming at Coney Island or Revere Beach is more expensive than in the "old swimming hole."

Of course in the city there are neighborhood movies—but every hamlet has its movies.

On the other hand, workers in a factory in a moderate sized town live in cottages rather than tenements, combine gardening with shop craft, sleep in quiet and, because the “boss” and his men have many intimate social contacts outside of working hours, the worst rigor of discipline is lacking during the working day. From the human viewpoint, therefore, a shifting of factories from great centers is advantageous. In so far as modern industrial progress is conducive to this change it is in accord with human welfare.

CHAPTER VII

THE PEDDLER—HIS SERVICES TO EARLY MANUFACTURERS

The Call of the Road.—Deeply imbedded in human nature is the nomadic spirit. Distance enchants. In every age, in every social order, individuals have yielded to the urge to visit strange and remote outlands. Americans, the progeny of migrants, always have been prone to “pull up stakes” in order to discover what lies beyond the horizon; and if funds were scanty, as often has been the case, the traveller financed his expedition by engaging in trade or practicing one or more crafts en route. The college lad who buys a battered Ford and blithely starts for the opposite coast, planning to work his passage by odd jobs, merely modernizes the deeds of his ancestors who, when the adventurous blood of youth surged their veins, packed a small tin trunk with locally manufactured gadgets and afoot traded their way to the frontier. Methods have differed, but the inspiration has been constant.

To the natural disposition of young men to rove there was added in early New England the prompting of shortage of economic opportunities at home. The sea and the back lands both beckoned to restless spirits; so some became sailors while others temporarily adopted the trade of the peddler, and a few combined both callings.

In the records of the first century of lands occupied about Chesapeake Bay, Albemarle and Pamlico Sounds, it is set forth that small boats manned by Yankees and loaded with knickknacks picked up on the wharves of Salem, Boston, New Haven and New York, plied the southern waters, exchanging their varied cargoes for southern products. These colonial maritime peddlers, however, had much less influence upon New England manufacturing than those who later fared overland on foot, on horseback, or in cleverly contrived wagons.

First Yankee Tin-Peddlers.—While there were “Yankee peddlers” prior to 1740 the institution denominated by that term was started by William and Edgar Pattison who left Tyrone County, Ireland, in 1738 to settle in the village of Berlin, near Hartford, Connecticut. These two brothers, having learned the tinsmith’s trade in England, began making tin utensils after their arrival in Berlin. American kitchen and tableware previously had been whittled from wood, shaped from leather, cast from pewter, or produced from copper. The rare articles of tinware owned by colonists were imported from England at a high price. Hence a local American manufacturer of tin commanded an eager market for his goods.

The Pattisons bought English sheet tin at Boston, carried it by horseback to their Connecticut Valley village, and there cut and shaped it. Their tools were shears, anvils, and wooden mallets; their principal asset was their skill. When the brothers had produced a goodly supply of wares they packed these into sacks, and then, slinging the sacks over their shoulders, they trudged through the near-by settlements, making house-to-house calls until all the bright tinware was sold. Thus began the Yankee tin-peddler, destined to bring fame and fortune to New England.

Within a short time the range of the brothers’ travels became too great to be covered on foot, so ingenious baskets were fitted to saddles and the peddlers did their business on horseback. As their trade continued to increase, young apprentices were taught the art of making tin. The brightest, most reckless young men in the home town were sent out on the road with one or the other of the brothers to learn the lures of a trade involving on one side shining tin and, on the other, caraway and mustard seeds, feathers, old metal, or “what have you?” These young men constituted that great institution, the Yankee tin-peddlers. They were brave, for no coward would venture alone on long journeys at that time; they were clever, for they had no rules to guide them through the accidents of the road; they were highly immoral, for they were always among strangers and alone; they were keen-witted, for they were pitted daily against sharp pioneers; and they were full of tricks, for they would do anything to make a trade.

Rise of Tinware Industry.—The neighbors of the Pattison brothers envied and emulated their success, and soon that region in Connecticut where the Pattisons had settled became the recognized center for tinware. Each home shop sent its corps of men to tour the colonies. The nasal-toned, hawk-beaked, wiry, psalm-singing, youthful Yankee peddler became known wherever two or three people were gathered together. When the nation began to build turnpikes in 1790, these roads enlarged the peddler's operations, for they allowed him to use a wagon of his own invention instead of the back of a horse. The wagon was designed to carry the most wares in the least space, and was a maze of secret compartments, hooks and drawers. With the coming of canals and roads the peddlers perfected their organization.

Single or two-horse wagons were started from Connecticut in the spring, and traveled north, south, and west toward prearranged depots. In the fall, workmen from the Connecticut shops were sent by water to such central points as Montreal, Richmond, Charleston or Albany. There they made new articles of tin from raw materials which they had carried with them. Peddlers worked toward these central points to replenish their wagons and then struck into the interior for the winter, making house-to-house canvass of their wares. In this way, literally every hamlet in the country came to know and use the Yankee notions sold by the peddlers.

Selling Organization.—After 1820 roads had been so much improved that depots could be established at favorable inland points, as well as at places reached by waterways, making it possible to extend operations still further inland until even the most remote frontier was reached. Since the currency was in a chaotic state, much of the trading was by simple barter, the peddler taking household products to the towns and town products to the farms, until such times as he could sell for actual money. At the end of a six or eight months' trip the peddler sold his horse and wagon wherever he could do so to his best advantage, and then made his way back to Connecticut with his gains for his employer. Thus was built a strong distributing and selling organization. Few of the peddlers were individual traders; most of them too young and

too poor to finance their own business, were employed by a few capitalist tin-makers in Connecticut. The supply stations were established at strategic points and from these regular routes ramified in all directions. Thus, the whole country was controlled by a complete distributing system whose headquarters were in New England.

All this elaborate organization was in the sales department of the business; its manufacture remained a simple thing. A small shop, rarely employing as many as fifteen or twenty men and seldom conducted on what we know as the factory system, sufficed to keep several times as many peddlers supplied. Connecticut was the recognized leader in the tin manufacturing industry down to 1850, but the state does not owe so much to the value of the goods produced or to the number of men employed at home as it does to the perfection of an intricate selling system and the extension of the fame of Connecticut and New England as a manufacturer of useful articles.

Articles Carried by Peddlers.—The organization created to sell tinware was seized by manufacturers of other goods which reached consumers by way of the peddler's cart. These other articles added to the peddler's stock, necessarily small and light, were of bewildering variety. A suggestive but by no means exhaustive list of the merchandise stowed in the picturesque carts is as follows:

Baskets	Embroidery	Shawls
Books	Fish	Shoes
Brushes	Hats	Shoelaces
Brooms	Indigo	Silverware
Buttons	Jewelry	Snuff Boxes
Candles	Jew's-Harps	Spectacles
Carpet Slippers	Knit Goods	Spinning Wheels
Chairs	Laces	Statuettes
Clocks	Melodeons	Stockings
Clothespins	Nursery Stock	Suspenders
Combs	Oysters	Tatting
Cutlery	Patent Medicines	Textile Materials
Crochet	Pins	Tobacco
Drugs	Pottery	Tracts
Dyestuffs	Razors	Yarns
Essences	Seeds	Wooden Ware

To show how the peddler's marketing organization helped establish several New England manufactures we can cull from the list of peddler's articles certain ones for elaboration.

Connecticut Brass Industry.—The brass industry had its humble beginning in the manufacture of buttons. The first buttons were made of pewter, and sold for as high as a dollar apiece. Pewter buttons gave way before those made from brass, an alloy made from copper and zinc. The copper for the brass buttons was obtained from old sheathing in the shipyards of Connecticut, Rhode Island, and Massachusetts, from worn-out copper kettles of the New England rum distilleries and from copper articles picked up in barter by peddlers. This copper was mixed with imported zinc and made into sheet brass in mills that had cast and rolled iron in the western part of Connecticut before the Revolution. Since there was no market for sheet brass, none of its producers thought of selling it outside of the narrow region around Litchfield and Waterbury, Connecticut, where it was made; but they stamped buttons out of it because these articles did have a ready market and, moreover, could be easily carried long distances because they had such high value in proportion to their bulk and weight.

Opposition to Home Products.—However, in attempting to reach a market, the buttonmakers struck a snag in the opposition of the regular dealers to handling American-made goods, then held in universal disapproval by merchants. Inasmuch as buttons were made of metal, they were usually sold by hardware dealers, but the dealers refused to have anything to do with American-made buttons, claiming that English buttons were superior in quality and appearance. The infant industry seemed about to meet an untimely death. Shut out of one market the experimenters reached a better, more direct one, by handing over their buttons to the peddlers. Since the buttons took little room, the peddler could easily add them to his stock-in-trade. Through him they found a ready and increasing sale, for although town-living dealers supplying fashionable, luxury-loving, prejudiced town citizens might deride or ignore the American product, the peddler

thrust beyond the towns and catered to country farmers whose tastes were uninfluenced by foreign contacts and whose predilections were for American products.

Expansion of Industry.—Although brass was first made to supply buttons, improvements in casting and rolling brass so increased the supply of the sheet metal that the demands for buttons alone could not utilize the surplus; new uses had to be created. The new products were all small, such as brass kettles and lamps to hang alongside the tin vessels on the peddler's wagon or wire drawn from the sheet brass and then stamped into pins or hooks and eyes. The peddler was glad to add these things to his outfit, because the greater variety of wares he had to display, the more he was sure of striking a trade.

Between the earlier tin-manufacturing industry and the later brass there were many unlike features. The making of articles from tin always remained a simple, small-scale affair, whereas brass manufactures grew to giant proportions; the tinshops employed but few workers, while the brass mills and factories eventually supplied jobs for thousands of skilled men and women; the Connecticut tin business was short lived, but the brass has been a permanent valuable addition to the state. Nevertheless, the great brass industry is greatly indebted to the tin which went before it, for without the distributing organization provided for marketing tin utensils, the first brass buttons upon whose manufacture the modern brass industry was based could have found few buyers.

The Clock Industry.—For the manufacturing of clocks, likewise, the peddler was the means of reaching the market. In our colonial period, clocks were ponderous affairs made of wood and standing higher than a man. The making of these clocks was one of the ways by which our forefathers eked out the living denied them by the thin, rock-strewn soil of New England. Some of the Connecticut settlers applied their ingenuity toward making a clock cheap enough to go into the ordinary home, and less of a curiosity or luxury. The first improvement instituted was the making of interchangeable parts, which alone greatly increased the production of clocks and cheapened their cost. Next, the clock was made

small enough to stand upon a shelf. This advance marked a new era. The small shelf clocks, like buttons and pins, found their market on the peddler's wagon and met with an astonishing sale; no longer were clocks the badges of the rich, for thousands of poor men bought them. Many attempts to replace wood by metal, or even glass, in the clock parts failed because metal was expensive and wood cheap; not until 1837 was brass cheap enough to compete with wood. That year a radical improvement was made. First, the clocks were constructed to run for one day only and not for the customary eight days, and then the interchangeable parts were made of stamped brass, and the price was \$6, a figure so astoundingly low that Connecticut became the nation's timekeeper. Peddlers carried the new brass clocks into every nook and cranny of the land, becoming nearly as famous for clocks and as "clock-tinkerers" as they had been for tin. It was this wide sale that gave the industry its start. These small cheap brass clocks were the direct ancestors of the famous "dollar watch," which before the advent of the automobile was America's most characteristic manufactured product. The mass production of standardized interchangeable parts yielded a watch so low in price, yet so serviceable, that the whole world kept its appointments to its vigorous tick. The brass clock and the later dollar watch belong to the same industrial category as the Ford and the Chevrolet.

Other Articles Peddled.—But the brass and clock industries were not the sole beneficiaries of the peddler's marketing organization. In the field of luxuries, the peddler carried Connecticut-made silver knives, forks and spoons after the method of silver-plating on a German-silver foundation was discovered. The story of the beginning of the manufacture of builders' hardware, later so highly localized in New Britain and Bristol, Connecticut, would show the same dependence upon the peddler. Likewise, Leominster, Massachusetts, led the nation in the manufacture of horn combs and hair ornaments because the peddlers opened the markets to the first producers of these articles. The cheap jewelry that has made Attleboro, Massachusetts, famous was another product for which the peddlers provided the first means of reaching buyers. Suspenders, called "galluses" by the peddlers, were

among the first commodities made from web elastic. This industry starting at Middletown, Connecticut, spread to other Connecticut towns and is now found in the same places. The peddlers gave these factories their start. Similar illustrations are furnished by the hosiery manufactures of Philadelphia and Massachusetts, the pottery industry of New Jersey and Vermont, and many others. Enough has been said to show that the peddler, by furnishing the connecting link between a widespread scattered demand and a localized producer, aided materially in establishing many important manufactures in the regions where now they are found.

Indirect Service of Peddler System.—So long as the peddlers kept to the road they were directly aiding incipient manufacturing enterprises. But peddling was primarily a young man's business. As peddlers reached maturity they usually retired from the road. A goodly number of ex-peddlers opened retail stores in towns selected during their roving days. As buyers for these stores the former peddlers continued to patronize the manufacturers with whom they had dealt. Moreover, the original depositories or storage houses located at strategic points to replenish wagonmen's stocks were in several instances converted into regular wholesale establishments. That is, a new distributing system grew up, but oftentimes the same individuals composed it as had furnished the personnel for the peddler system. The old chain comprised a New England manufacturer, a peddlers' depot, and individual peddlers with their carts. The new chain included the same manufacturers, the depot converted into a permanent wholesale house, and the former peddlers operating retail stores. That this continuation of established business relationships perpetuated and expanded existing channels of trade is of the utmost importance, as any modern business man will recognize. For few things in business are harder to start or more difficult to change than a deeply grooved channel of trade.

Before the new distributive system was crystallized the peddler intervened in another way. A few peddlers abandoned house-to-house calls, and instead became perambulating wholesalers who limited their selling to retail crossroad stores. The most famous



PLATE 5. Carter's Famous "Four-Horse" Peddler's Sample Wagon.

(Courtesy A. H. Carter, Lebanon, N. H.)

H. W. Carter in his own time was called the "Merchant Prince of Northern New England," but in retrospect we might fittingly name him New England's First Modern Advertiser. His means differed but his methods were similar to ours. He deliberately planned his necessary equipment so as to attract maximum attention and fix his name and business in the public mind. Not only did he use four horses instead of a pair on his peddler's wagons and later on his sample carts, but these horses were perfectly matched, spirited blacks instead of the drooping hags generally seen hauling peddlers' outfits. Carter's harness trimmings were pure silver while the wagons or carts not only were gaily

painted but on the sidepanels and tail-board carried scenic works from an artist's brush. The tail-board drawing was a vivid picture of Carter's own "mansion" with its outlying warehouses and retail shop. The wagons and carts were made to Carter's special order at the famous works in Concord (N. H.).

Carter himself dressed always in the height of dandified fashion and often his wife, a noted beauty, accompanied him on his trips. She, too, was a living fashion plate. Carter used cuts of his Four-Horse Wagons as trade-marks on all goods that could carry a label. Our illustration is printed from the only existing copper plate used by Carter for his own trade-mark labels.

Beginning with great wagons piled with trade goods carried to country retailers, Carter changed with the arrival of railroads to carts furnished only with samples. Still later Carter's salesmen with order books used the railroads and mails. Meanwhile the headquarters at Lebanon was altered in part from a warehouse with an attached local retail store to a factory. Gradually the factory operations absorbed all the warehouse space. The factory now specializing on the making of overalls and mackinaws is still in operation. Carter's story, therefore, is an epitome of much American industrial history.

of these wholesale peddlers in New England was Henry W. Carter of Lebanon, New Hampshire. This village is located near the junction of the Connecticut and White Rivers and is on the overland trail to the Merrimac River, by which Manchester, Concord and Boston are reached. Thus, natural highways pivoted on Lebanon and stretched east, west, north, and south; it is the natural gateway to all of northwestern New Hampshire and Vermont up to the Canadian boundary. White River Junction, five miles from Lebanon, is now the principal northern railway freight distribution point in New England. Here, then, Carter established his headquarters. His wagons were several times the size of the ordinary peddler's cart and were drawn by four to six horses. The contents of each wagon were as varied as those on the shelves of the retail general stores they served. As late as 1887 one store five miles from Lebanon sold to two successive customers from its regular stock a goose yoke and a pulpit for a country church. The value of goods carried in one Carter wagon might be several thousand dollars. Each wagon travelled a regular route, touching two or three score towns and villages, and made three or four round trips a year. This was peddling de luxe. Members of the Carter family are still doing business in Lebanon, but are now manufacturers.

Other Wayfarers.—Peddlers were by no means the sole itinerants padding the dust of 19th century American roads. When the country was young and the population scattered, specialists in many callings, finding too few customers in one place, were forced to seek their markets wherever they could find them. Thus, there were many wandering craftsmen, among them candle-makers, weavers, tailors, cobblers, loom-fixers, tanners and butchers. There were also professional men who travelled circuits; doctors, lawyers, preachers, dentists, painters and other artists, and dancing masters, all belonged to the ambulatory brotherhood. Until he was forty years old, Samuel F. B. Morse, inventor of the telegraph, was a wandering portrait painter. It was upon one of his first journeys into northern New England that his heart was captured by a maiden who lived at Concord, New Hampshire. The gypsy trail also was followed by actors, and showmen, includ-

ing the thrilling circus. Peddlers, therefore, were but one of many contemporary groups, the peddlers carrying goods, the others services, to out of the way places.

When the Ohio and Mississippi became national highways all of the wanderers, including the peddlers, forsook landways and land conveyances for the waterways and boats. The Ohio River peddler put a country store on a keel and floated it down the river, making frequent stops at farms and villages.

The Decline of the Peddler.—The system of peddling arose from lack of communication and transportation. Wherever roads and canals were built, the retail store followed. The proprietors of these stores, often former peddlers, were the deadly foes of the peddling system. Most people preferred to trade with a member of their own community whom they could trust or hold responsible, rather than with the stranger of brief sojourn and evil reputation. The storekeepers played upon this trait to their own advantage. They also pointed out that as residents they paid taxes, whereas itinerants not only failed to support the community but carried off its surplus wealth. Hence, heavy license fees were imposed upon peddlers and sometimes they were additionally limited to trading in the products of the state in which they found themselves. These tactics drove the peddlers into more remote places, where they were still welcome and free because improvements in communication and transportation had not yet reached such isolated dwellings. But when the railroads were built the peddler's knell was sounded. The railroads gradually penetrated nearly all the nooks and crannies of the country and wherever they went the storekeepers followed. The few places remote from railroads were the only areas still open to the jingling tin-cart. Even there the peddler was pursued and driven out by the rural free delivery and parcel post systems augmented by the seductive mail-order catalogs.

The Jewish Peddler.—Long before communication and transportation were brought to a stage of universal usefulness Yankees forsook peddling. After the factory system was introduced into New England the economic situation was mended, for

there were jobs enough at home for all seekers. The flaming youth who craved adventure no longer courted it by peddling—for that was fast becoming humdrum—but pursued it across the Appalachians and in the wilderness beyond. The Yankee peddler was succeeded by the Jew.

Although Spanish and Portuguese Jews instituted congregations in Newport, Rhode Island and New Amsterdam in the 17th century, they did not enter retail trades, manufacturing or peddling, but instead took a leading place as merchants in foreign trade. The esteem in which Mayflower descendants are held in New England, Knickerbocker blood in New York, First Families in Virginia, and Forty-Niners in California is equalled by the respect shown by modern American Jews to the few survivors of the families of Spanish and Portuguese Jews who came to America with the first settlers.

It was not until the decade of 1830 that the great Jewish migration to the United States started, a movement inaugurated by restrictive measures imposed upon them in their native German states. A large number of these German Jews had been traders and some had been peddlers in Germany. Accordingly, upon arrival in America they entered the business to which they were trained. The Yankees were forsaking peddling at this time, and the Jews picked up the reins the Yankees dropped. Those few Yankees who stubbornly clung to their seats upon the tin-wagons were pushed off by the hungry Jews, whose wits had been sharpened by centuries of suffering. Rare indeed was the bareboned Yankee whose shrewdness was sufficient to withstand the competition of the subtle, bearded Semitic.

To the Jews, peddling was but a springboard to fortune. As soon as the Jewish peddler had gathered a little capital he sold his peddler's equipment to a more recent Jewish immigrant and launched himself—as some of his Yankee predecessors had done—into retail business. The names picked out in gold leaf upon the plate glass windows of many a department store once were scratched in chalk upon a lop-wheeled peddler's cart. By the decade of the eighties, when the Russian and Polish Jews crowded the steerage of transatlantic steamers, the German Jews had fin-

ished with peddling and left the remnants of this decaying activity to their newly arrived and indigent distant cousins. Curiously, the latter days of peddling saw its practitioners, not on the roads winding through valleys sparsely populated with farmers, but in the hard paved alleys slit through teeming tenements. Pushcart men were the faded caricatures of a once hardy, vigorous calling.

Peddling Revived.—Hardly had the dust settled after the last passage of the last peddler's wagon when a new era in peddling began. Starting as a toy for the rich, the automobile became the joy of the masses. The pleasure car was followed by the ubiquitous, omnipotent truck.

With hard surfaced roads increasing in mileage weekly and with improved roads not hard surfaced penetrating every stronghold, peddling was revived. It bore a striking resemblance to its ancestor. The travelling library is a recognizable relative of the 18th century book peddler of whom Pastor Weems, saccharine biographer of Washington, was most famous. The moving picture outfit, mounted on a truck and amusing the countryside, is heir to the wandering showman. The complete grocery store on rubber tires that chugs to the door of the farmer's kitchen is a descendant of the Yankee wagon, gaily painted and containing nearly everything now found on Woolworth's notion counters. All of these motorized peddling enterprises actually exist, but whether or not they betoken a new large-scale return to peddling it is too early to say.

Although we must admit that the Yankee peddler of former days deserved his reputation for being oversharp in a bargain, we must not let this fact blind us to the real service he rendered. Because this peripatetic merchant in his zeal for a bargain sometimes sold hams made of basswood, cheese of white oak, and wooden nutmegs, these are the things on which his reputation rests, and not the service he provided to the struggling industries of his day by furnishing a marketing system for their products.

When other means were lacking he afforded a feasible way of getting goods into the hands of the users of the goods. Production without sale is failure; distribution and consumption are the

life of trade. Without the peddler as distributor, many of New England's industries would have waited a much longer time to be born and might have been abortive. We should honor the peddler for the service he rendered, rather than despise him for the manner in which the service was contributed.

CHAPTER VIII

IRON

Predominance of Market.—The story of iron and steel in the United States turns about one central theme, the market for the products. As the market has changed, so the location of the industry has shifted, its technique has advanced, and its output has been given new forms. Raw materials, especially fuel, have had an important bearing upon the manufacture of iron, particularly upon the localization of the primary branch that transmutes ore into pig iron; nevertheless, the power of the market has dominated raw materials, and even forced the adoption of new fuels. Consequently, the market has been at all times the most influential factor directing the destinies of the iron and steel business.

During the colonizing era the market for iron was strictly limited to the locality where the iron was produced, but later on, when commerce absorbed the attention of the settlements, iron-makers found an outlet among shipbuilders and distillers. After prospering for a hundred years in this market, the masters of forges discovered new claimants for their goods among the first pioneers who pushed westward to form settlements in the valleys that front the Alleghenies. When two wars with Great Britain left America free to develop her own resources, both the industrial expansion of the East and the agricultural advancement of the lands west of the Alleghenies provided an admirable stimulus to melters and fabricators of iron. But it was not until the railroads came into prominence in the years succeeding 1830 that the really great markets for iron were discovered. For decades the railroads bought from a third to a half of the annual output of the iron and steel works. For building and construction the use of steel gave mills and furnaces a valuable outlet, and the needs of the oil business, of mines and of water-works constituted

another constant market. The rapidly increasing output of automobiles in recent years enlarged very greatly the market for iron and steel. This one manufacturing industry annually buys about $12\frac{1}{2}\%$ of the total United States production of finished rolled iron and steel. Railroads, the building industry, the mineral and water industries and the automotive industry consume two-thirds of all steel produced in America.

Early Local Forges.—No colonial farm or village had a great need for iron products, and even that little could be dispensed with in times of stress or places of scarcity. Log cabins were often made without nails by crossing the logs one over the other and allowing the ends to project. More elaborate cabins were held together by fitting the logs into each other by means of notches, or by tenon joints with large wooden pegs. Sometimes, too, beams were held in place by rawhide thongs. The Mission at Monterey, California, was built in this manner, as may be seen even to this day. Nevertheless, a small quantity of iron was everywhere desirable for nails, pots, kettles, or tools. After permanent settlements had been made upon the Atlantic coast there was not a colony, except Georgia—the last colony settled, and one that was not prosperous until after the Revolutionary War—that did not establish forges for itself.

Since the American Indians knew nothing of iron and its uses, iron in America was contemporary with the white immigrants. The first discovery of iron was made in North Carolina, in 1585, and the Virginia colony sent iron ore to England as early as 1608. Eleven years later, upon the arrival of skilled iron workers, a forge was built at Falling Creek, only to be destroyed in 1622 in a general massacre of the whites by the Indians. Iron manufacture was not resumed in Virginia for about a hundred years. The second iron works in America were erected in a meadow bordering the Saugus River, near Lynn, Massachusetts, where iron had been discovered about 1629. A foundry was established there in 1642 under the direction of John Winthrop, Jr. Likewise, in each colony surprisingly soon after settlement iron works were erected.

The reasons for these forges are not difficult to perceive. In

the first place, during the 17th century the British iron industry was declining because of lack of charcoal. Moreover, iron was relatively expensive to import; its bulk or weight was great in proportion to value, and the danger of injury was ever present, particularly in the case of brittle cast articles such as pots or kettles. It was estimated that because of the cost of transportation, the distance from Great Britain to the colonies gave the American iron-makers the equivalent of a 25% protective duty. In the colonies themselves, the same factor—difficult transportation—kept the industry local; overland carriage was impossible and coastwise traffic impracticable because of the weight or brittleness of iron. As a result, each local market was supplied from a local source; indeed, the assemblies of Virginia (1662) and Massachusetts (1637) deliberately kept their iron industry local by forbidding the export of iron.

The three important raw materials—ore, fuel and lime—were easy to obtain. There was not a colony in which iron ore did not exist in some usable form. As for fuel, there was a superabundance, since charcoal was employed for that purpose. Lime, which served as a flux—uniting with certain impurities of the ore and so helping to remove them—was widely distributed and existed in many varieties ranging from common limestone to oyster shells. With the three important raw materials present it was a simple matter to reduce ore to metal because the business could be done on a small scale with elementary apparatus. Most early iron-making equipment comprised nothing more elaborate than small forges, hand-bellows, anvils, and hammers. Each community possessed iron-making facilities as part of its necessary outfit.

Nail Industry.—In addition to furnishing farmers and townsmen with pots, kettles and tools, there always was a demand for a large amount of bar iron to be slit into nails, but, before the Revolution all nails were made by hand and consequently were scarce. Wood was so cheap and nails so expensive that settlers upon migrating to a new area sometimes burned their cabins and raked the nails out of the ashes. The nails were carried to the new home and entered into its construction. Since it required no

training to hammer out nails from bar iron, it was customary for farmers to spend their idle time in the winter at this occupation, and in many homes it was an evening job throughout the whole year. Tacks were made in the same way and, as a result, nails or tacks frequently took the place of money or agricultural produce when the farmer went to the nearest village store to barter.

In 1790 when Jacob Perkins of Massachusetts invented a slitting and heading machine that reduced the cost of nail-making to one-third that of the household product, he began the elimination of the little forges by the hearthstone. Between 1790 and 1800, for example, there were 34 patents granted for nail-making machines and by 1825 the total was 120. This is a measure of the importance of nails to young growing settlements. In 1810 nail rods comprised 25% of the total output of iron. Nail rods were sold at stores in the remote back country of the South until quite recent years, and tack manufacture continued as a household industry until 1830. These primitive methods now are obsolete because a modern nail mill contains 150 to 300 separate automatic machines, each clipping out nails at the rate of 150 to 350 per minute.

Continuance of Local Production.—Despite the enormous development of the modern iron and steel industry, local forges have existed down to our own times, usually in the byways of the country, such as the Kentucky mountains, far removed from active contact with the world. The forges continued in use there because the countryside was inaccessible, the same factor that gave rise to the original small local forges. A few forges have been nearer civilization and were known as “high-water forges,” that is, they operated only when iron was so high priced that their relatively high cost of production could be met. For example, Louisville, Kentucky, in its petition for a government armor plate plant in 1917 urged the advantage of its city in possessing near-by a string of these “high-water” furnaces that would offset any possible shortage in pig iron. In the main, however, the strictly local iron business was confined to colonial times.

Massachusetts as Leader.—Even then, despite the wide diffusion of iron-making, one colony, Massachusetts, soon sur-

passed all the others by a generous margin and led the country in production between 1650 and 1750. After the Saugus Works, a second iron establishment was erected at Braintree, Massachusetts, in 1646, and a third at Taunton, now Raynham, in 1652. In the counties about Massachusetts Bay thirty-one forges or bloomeries were started during the succeeding century and, doubtless, many more that never were dignified by record in local accounts. The greatest concentration of works was about Narragansett Bay and Cape Cod Bay (Bristol and Plymouth Counties). That Massachusetts should hold the primary position in the production of iron points to the importance of a market, for Massachusetts alone of all the colonies presented a considerable outlet for iron goods. This was her shipbuilding and commerce.

Maritime Demand.—Iron entered into marine outfitting in many ways, the most obvious, of course, being the nails and bolts that held ships together. As has been shown, while nail manufacture was largely a household industry, many furnaces were necessary to furnish the bar iron. It was in Massachusetts where the largest market existed that nail-making machines first became common, and they were in general use there by 1795. An iron accessory that every vessel possessed was the ship anchor. Each vessel required at least two, and, inasmuch as fishing was done from small boats, each dory had to have its own small anchor. The manufacture of anchors consequently was a business of no small value. Moreover, since no sea was safe from marauders, and pirates lurked off the mouth of every river, and each merchantman was the prize sought by numerous freebooters, even the smallest trading vessels carried an extremely heavy armament for protection or for aggression if opportunity arose. Not only were these cannon the product of American works, but the balls, too, were supplied by our furnaces and forges. To be sure, many cannon were brass.

Other Sources of Demand.—Commerce bolstered the iron industry still further by bringing to Massachusetts raw materials that, in the process of refining, called for iron utensils.

Chief among these imported crude products were sugar and

molasses. In response to abundant raw materials and a market greater than the production, sugar-refining and rum manufacture flourished all along the shores of Massachusetts Bay. Rum, at that time, was an especially valuable product, in great demand. Inasmuch as the more southern colonies, notably Pennsylvania, turned surplus grain crops into beer and had no raw material for rum, the distilled spirit was an important article for commerce between the Atlantic colonies. The settlements upon Massachusetts Bay and near-by Narragansett Bay became the centers for distilling because they surrounded the principal molasses-importing towns, Salem, Boston, Newport and Providence. The distilleries concentrated upon such a small area constituted a market for iron ware by reason of the fact that the pipes, kettles, and stills were made from iron or copper. Likewise, the kettles for purifying crude sugar were of iron material.

Barrels for cargoes of molasses, rum, fish and sailors' food supplies were held together with wooden or iron bands; indeed in 1795 one-half of the output of iron was devoted to this purpose. The traffic in fish gave rise to the subsidiary industry of deriving salt from sea water by evaporation, a home job all along the shore of Massachusetts Bay and upon Cape Cod. This practice required large iron drying-pans. Hence iron manufacture was stimulated both directly and indirectly by fishing and commerce. Iron was manufactured in the very counties where commerce, fishing and shipbuilding flourished.

Market the Determining Factor.—That the market was the principal influence in iron production in Massachusetts may be made clearer by a hasty survey of other possible factors. Fuel can be dismissed at once, for when Massachusetts was most famous for iron (1650-1750), wood was everywhere abundant. Flux is usually easy of access where iron is produced, but eastern Massachusetts was lacking in lime-bearing stones and the iron-makers had recourse to marine shells to supply the deficiency. This was no hardship, it may be remarked, for oyster shells cost about 12 cents per ton of iron, whereas the limestone charge elsewhere ran very much higher, ranging from 62 cents to \$1.68 per ton of iron.

Eastern Massachusetts had no high-grade iron, although it was endowed with a poor variety known as bog ore, yielding from 25% to 50% of iron. As its name indicates, this ore was found in swamps or at the bottom of ponds, precipitated from the water by a minute marine life called *infusoria gaillonella ferruginea*. The ore lay from one-half to two feet deep, so a man in a boat working diligently with grappling irons or tongs could gather two tons in a day. Moreover, as the iron was deposited as long as the minute depositor remained alive, a new "crop" formed again in the same pond after an interval of twenty years. Thus one constricted area with a number of large ore-bearing ponds could keep a small-scale furnace in continuous operation. For example, a pond at Middleboro, Massachusetts, yielded 300 to 600 tons of ore a year for over sixty years.

Despite the numerous deposits of this bog ore in eastern Massachusetts, the demands of the industry outran the supply of raw material with the result that Massachusetts furnaces were supported by ore from New Jersey, Pennsylvania and Maryland, and the refiners of iron imported rough bars from Russia. In addition, home-coming trading vessels often carried scrap iron or ore to Massachusetts as ballast. Therefore, the industry was not any more dependent upon local ore than it was upon fuel or flux; the market was the dominant influence.

Westward Progress.—This situation was unchanged until about 1750, when settlements began to appear in valleys removed from the coast. In these was repeated the history of the older eastern communities; local iron-making at first supplied the newest local markets but eventually well-recognized centers were established.

The valleys chosen by these first American pioneers were those that cut across the foothills of the Alleghenies: the Connecticut, Housatonic, Mohawk, Champlain, Lehigh, Shenandoah, Cumberland and Tennessee. These valleys constituted almost a continuous highway from Alabama to Canada. While it was comparatively easy to travel north or south along these pathways, journeys westward were blocked by the Alleghenies or eastward by innumerable hills, especially in New England. As a conse-

quence, the new clearings were forced to be self-sustaining, for their wants could not be fulfilled by the established settlements that bordered the Atlantic. Among the pioneers in these valleys, therefore, a new market for iron goods arose that necessarily was dependent upon local production. Furthermore, the articles demanded by the frontiersmen were entirely different from those needed in shipbuilding or commerce and called for specialized iron manufacture.

Frontier Demand.—These settlers had a small but vital use for iron because life, sustenance and home depended upon a few iron tools. Foremost among these was the pioneer's gun, without which he would not dream of venturing forth. Protection in a wilderness full of enemies, sustenance in a land where food must be shot, clothing on a frontier where looms, fullers, and tailors were absent—all these wants were satisfied by a gun. Nearly every village had a gunsmith, often a retired peddler. The gunsmith manufactured guns from locally produced iron and did an extensive business in gun repairs, also requiring iron.

Next to his firearms the pioneer valued his axes, for with these he made his home and his barns, hewed his roadways and gathered his fuel. With no other tools than a gun and an axe, a man might live in security and comfort; nevertheless, most pioneers added to this equipment shovels, hoes and scythes, as well as pots and kettles.

Potash.—Of the large kettles there were two varieties that were unusually important, one for potash and the other for sugar. Potash was valued highly in the world's commerce because wood was scarce in the old countries, while potash was prized for fertilizer or for the manufacture of soap and many other articles. The American frontiersman found potash a most desirable commodity upon which to spend his spare time, for the trees that supplied the raw material encumbered his land, while the finished product brought a good price and, moreover, could be easily transported for long distances. Frequently, the potash was further refined at the farm and sold as pearlsh. There were so few things that a pioneer could sell or exchange for necessities that

this almost ideal riddance of rubbish for a respectable remuneration could by no means be overlooked.

The kettles or pots used for potash-making were very large, frequently weighing as much as a thousand pounds, and taxed the iron-makers' resources to the utmost. Since every frontiersman from Vermont to Alabama required at least one such kettle, the forge masters were given no little work. Similar kettles were necessary for reducing maple sap to syrup or sugar. Unless he was willing to do without sweetening, or to depend on honey and corn syrup, every settler beyond the reach of the cane sugar refineries on the coast was forced to go into the forest every spring and manufacture his year's supply from maple sap. This common practice again reacted upon iron-makers, for the kettles needed were many while the number of iron-makers was few, and even the best furnace men could not turn out iron for more than four such kettles a week.

Supply of Materials.—The entire length of the valleys from north to south was underlain by limestone, and veins of iron abounded from Canada to Alabama. Rock ore and lime were therefore present where they were most needed, and the third requisite, wood for charcoal fuel, was of course ample in amount. As a result, wherever a small community appeared, a forge or furnace was almost certain to follow. These supplied local needs by local production from local materials.

Nevertheless, in the interior valleys, two places from which there was easiest access to markets became the leaders in frontier iron manufacture. These two favored communities were Salisbury, Connecticut, and Lancaster, Pennsylvania.

Iron Mines of Salisbury.—Near Salisbury, in 1732, on land granted to Yale College by the colony, ore was discovered. Two years later when the college disposed of its hundred acres, development of the iron deposits commenced and they have been mined ever since. Their greatest importance, however, was in the hundred years following 1750. In the late 18th century no less than thirty furnaces surrounded Salisbury within a circle of thirty miles. By 1800 there were fifty bloomery forges in Litchfield

County, Connecticut, in which Salisbury is located, not to mention many others near-by in Massachusetts and New York.

Salisbury iron was highly esteemed for two reasons: one, the unusual quality of the iron; the other, the ease with which it could be carried to market. The ore yielded a metal which was equalled in only one other locality—the Juniata Valley of Pennsylvania—and was particularly adapted to the manufacture of firearms or edge tools. In quality it stood as high as the best Swedish iron or even English mild steel. Furthermore, the ore deposits were so located that they commanded the routes north and south along the Connecticut, Housatonic, Mohawk and Hudson River valleys. Later the Erie Canal provided a water way to the western market.

Water carriage was essential for the existence of any iron works that were situated beyond a few miles of land haul from the consuming market. In 1783 the cost of transporting one ton of freight by land from Albany to Fort George, a distance of 65 miles, was \$32, or 49 cents a ton-mile. On the other hand, a ton could be carried from Canada to New York City by way of Lake Champlain and the Hudson for \$55, or about 12 cents a ton-mile. Hence a heavy commodity, such as iron, could be conveyed only a short distance by the expensive overland methods, but might travel four times as far by water. That helps to explain why Salisbury iron could enter New York City, 75 miles away, and why the products of Lancaster, Pennsylvania, commonly were sold in Baltimore, more than 150 miles away, but reached by the Susquehanna River. Besides its high-grade ore and access to markets, Salisbury was surrounded by limestone and the encompassing Berkshire Hills were covered with forests.

Lancaster: Iron-Making Center.—Just as the Connecticut village stood at a point where the chief northern water highways were reached readily, so also Lancaster, Pennsylvania, held a corresponding strategic position upon the routes toward the south and southwest. The main artery of land travel extended from Philadelphia to Lancaster where one branch ran into the Great Valley southward, while a second turned westward by way of Harrisburg and the Juniata River. Lancaster, too, was the metropolis for a wide agricultural valley splendidly endowed with

fertile limestone soils. In 1777 Congress sat at Lancaster for a few days and from 1779 to 1812 this city was the capital of the State. In short, it was the largest and most important inland city in the country throughout the first quarter of the 19th century.

Here, then, was an admirable market for iron where settlers bound for the South or West could equip themselves at the place nearest to their future homes. The farmers of the surrounding country looked to the city for tools and utensils, and the needs of the city itself created a demand for iron goods. The natural means for supplying this market were at hand, for the whole of Lancaster County and its neighbor, Chester County, were dotted with deposits of iron and the entire area was underlain with limestone. The presence of ore, flux and forests for fuel removed every obstacle to an iron industry once a market was assured. Lancaster, therefore, became the center of an iron-producing region that claimed seventeen furnaces in 1786, and fifty years later boasted over one hundred, at which time it ranked among the principal iron-makers in the entire country.

Separation of Smelting and Rolling.—After Salisbury and Lancaster had become firmly established in iron-making, a curious situation arose, appearing then markedly for the first time, but repeated often in the subsequent history of iron; the smelting of iron from ore was separated from the manufacture of the pig iron into finished products.

The primary and secondary stages of iron manufacture are not equally affected by the same set of economic factors. The reduction of ore to metal often occurs where the raw materials are found, for although it is highly desirable that pig iron be manufactured near its market, it is not absolutely essential. On the other hand, rolling mills and foundries that work pig iron into a great variety of forms are less dependent upon close proximity to their raw materials—the pig iron—because pig iron is easily handled in bulk and is valuable enough to stand fairly long shipments. Rolling-mills, however, must necessarily be near their market, for finished iron articles are bulky, heavy, hard to handle, and relatively expensive to transport. Thus it comes about that furnaces and mills are often widely separated and that rolling-

mills are found where there is no local ore, fuel or flux. After 1750 the disappearance of both bog ore and forests from eastern Massachusetts caused the rolling-mills there to secure pig iron from the Salisbury district to the west, where ore and fuel were plentiful. In like manner, Lancaster supplied the foundries and rolling-mills of England with pig iron, shipping it by way of the Susquehanna River and the port of Baltimore.

Gun and Tool Making.—Although the expansion of the United States and the opening of new markets has brought about a relative and absolute decline in the importance of the Great Valley furnaces, yet in rather curious ways they have left their impress upon modern industrial life. To protect her own foundries and mills, England, in 1750, prohibited the colonies from fabricating iron, an order which was well obeyed on the Atlantic coast where English officers were numerous and the population relatively dense, but in the remote and isolated Great Valley the law was ignored and iron manufacture was carried on clandestinely.

Guns were the chief product for the reason that they had a ready sale, a high value, and were easily carried or hidden. So numerous were the gun-makers in the hills along the Great Valley that the Continental Congress called them together at Springfield, Massachusetts, and at Harpers Ferry, Virginia, to manufacture arms for the government. These two places were the seats of the first United States arsenals, established respectively in 1778 and 1794. From Springfield, gun-manufacture spread southward into Connecticut where the great factories at Hartford (Colt), New Haven (Winchester), and Bridgeport (Remington), are its direct descendants. Furthermore, the admirable quality of Salisbury iron gave rise to numerous edge tool works in the Housatonic, Naugatuck, and Connecticut River valleys where the edge tool business of the United States is now centered. Consequently, the iron industry of the Great Valley is not without its present significance, although the iron produced there is of little consequence except in Pennsylvania and Alabama.

Crossing the Alleghenies.—Until the Revolutionary War the American frontier was bounded by the Allegheny Mountains.

When the war closed, however, the great western migration began. Men who were pioneers by inclination, soldiers who had become infected with the roving spirit by their army service, farmers whose lands were encumbered with taxes and debt or who were discouraged by the low prices prevailing for agricultural products—in short, all those who were disappointed in the East—sought the West with high hopes for better fortune. They were joined by immigrants from foreign shores and the whole stream poured into what is now Ohio, Indiana, and Illinois.

Since every settler needed tools and utensils, this great transfer of people opened a new region for the production and disposal of iron wares. The mountains barred eastern iron-makers from the western market; the pioneers, accordingly, were compelled to establish their own works. The first furnace west of the Alleghenies was built in 1790 on a little stream known as Jacob's Creek, an affluent of the Youghiogheny. This frontier venture was named the Alliance Iron Works. Following this first furnace—whose ruins still stand—many scattered enterprises were inaugurated, but those that centered at Hanging Rock and Ironton became the most important. The earliest furnaces there were on the southern side of the Ohio, but in 1826-27 John Means, John Sparks and James Rogers built on the northern side the Union Furnace, with a capacity of three or four tons per day. John Campbell was another pioneer western ironmaster in the Hanging Rock district. One of his furnaces, the Hecla, became famous for the quality of its iron. Guns and armor plate made from Hecla iron were used in the Civil and Crimean Wars. The famous cannon called the "Swamp Angel" of Charleston Harbor was cast from Hecla iron. Ironton, the center of the Hanging Rock area, was planned and built by John Campbell. Although the pig iron of the new West was produced mostly around Hanging Rock and Ironton, the rolling mills were set up in Cincinnati and Pittsburgh so as to have more direct access to the market.

Cincinnati.—The favorite route to the West started at Philadelphia, advanced to Lancaster and Harrisburg, climbed the mountains to Pittsburgh, and then continued down the Ohio River to Cincinnati. There, trails into the interior of Ohio, Indiana, Ken-

tucky, and Tennessee crossed the river highway. At Cincinnati roads from the north, east, south, and west converged to a point; it was the common meeting place for the whole great interior between the Alleghenies and the Mississippi. As a consequence, it played the rôle formerly in a smaller way assigned to Lancaster. For fifty years Cincinnati proudly held title to the largest inland city in America and boasted that eventually it would be the greatest city in the world. The boast might possibly have been realized if the railroad had not become a factor. The difference between Cincinnati and Chicago, for example, is the difference between river and rail transportation.

So far as reaching the market was concerned, Cincinnati was, therefore, the ideal situation for a new seat of iron manufacture, and, as a matter of fact, a promising business did start there. Furnaces using local ore were erected across the Ohio River from Cincinnati in Kentucky and others were built in Ohio itself, but all of these undertakings suffered from lack of ore. The furnace activities eventually centered about Hanging Rock and Ironton, 150 miles east of the river metropolis.

On the other hand, the second stage of iron manufacture, represented by foundries and rolling-mills, shortly became one of the leading activities of Cincinnati. These very effectually reduced the price of iron to western consumers. For example, bar iron that sold in 1814 to 1818 for \$200 a ton was \$110 a ton in 1831, and castings that were as high as \$130 a ton in 1814 to 1818 could be purchased for \$60 a ton thirteen years later. In 1859 it was estimated that 50,000 people were directly or indirectly supported by the iron works. But Cincinnati always remained true to her tradition, seldom producing primary iron but specializing in the manufacture of tools, utensils, and stoves. It is noteworthy that all of these articles are most economically produced near their market, either because convenience is a factor of importance or on account of the expense of transportation.

Pittsburgh.—Next to Cincinnati the best location for an iron industry was Pittsburgh. Until the Civil War, the story of Pittsburgh resembled that of Cincinnati. An attempt was made to smelt iron at Pittsburgh in 1792, but this was abandoned within two

years due to lack of ore. No further effort to erect blast furnaces took place; in fact, Pittsburgh produced no pig iron and possessed no blast furnaces until 1859, just before the opening of the Civil War.

Instead, rolling-mills absorbed all the attention of the Smoky City's ironmasters; the first mill appeared in 1812 and it was followed soon afterward by others. As early as 1829 there was one plant capable of turning out 100 plows a day. The market is strongly reflected in this item, for, at that time, the grain belt was confined to Ohio, Indiana, Illinois, Kentucky and Tennessee, all easily reached from Pittsburgh by way of the Ohio River. The demand of a frontier market is also apparent in Pittsburgh's other iron products; boiler iron for the river steamboats; hoop iron for pork and whisky barrels; ties for cotton bales; stove iron; and ax, hoe, or shovel blanks.

As has been said, Pittsburgh itself had no ore, but in the upper reaches of the Monongahela River, from the very town of Connellsville 50 miles southeast of Pittsburgh, which later furnished coke that was the world's standard, ore was mined and reduced in local furnaces and shipped to Pittsburgh. This business became great enough to mark the region as one of the principal iron-producing areas west of the Allegheny Mountains, a position it held until 1850 when Lake Superior ore began to displace that from the Monongahela. But Pittsburgh reached further than the Fayette County furnaces, for the Juniata River district east of the Alleghenies, famous for the quality of its product, was called upon to furnish bar iron and blooms for Pittsburgh's rolling-mills. The high value of the Juniata iron enabled it to stand the expense of the rough journey over the mountains to Pittsburgh. The customary method of transportation was to bend the bars of iron into the shape of an inverted U and put them over the backs of horses. These traveled in pack trains of fifteen, each horse carrying 200 pounds, and the whole cavalcade under the guidance of two men. When the Pennsylvania Canal was completed, the Juniata iron went by water to Pittsburgh. Despite the hardships and expense of carriage, by far the greater part of Juniata iron was sold to the Pittsburgh mills. The Cambria Iron Company was instituted at Johnstown, Pennsylvania, when that

town was the head of navigation on the western division of the Pennsylvania Canal.

Thus the service performed by Salisbury iron for the East was rendered by Juniata iron for the West; it took the place of modern steel in tools, such as picks, axes, hoes, and some shovels.

Notwithstanding the lack of ore in the immediate neighborhood, both Cincinnati and Pittsburgh rose to prominence in the iron business, but due to that lack, both limited their activities to iron rolling or casting. Each city supplied such articles as an agricultural frontier region most needed. The Ohio and Pennsylvania furnaces, including those in Connellsville itself, relied upon charcoal for fuel. Hence, in the case of these two cities up to the time of the Civil War, the controlling factor in their iron history was clearly their advantageous location in respect to near-by markets.

Growth in the East.—Meanwhile, the iron industry had been expanding in the older East to such an extent that, despite the growing importance of the western furnaces and mills, the principal production of iron remained in the East where the population was greatest and the demand largest and most varied. The bid for any commodity eventually is reflected in a demand for iron, for even if the article itself is fashioned from another material, it requires iron tools or iron machinery in some stage of its manufacture. Hence, the rise of the textile industry in the East called for iron, for although the frames of the early machines were wood, many of the parts were iron. For example, the cards or combs by means of which the textile fibers were straightened and caused to lie parallel, were made from iron wire. This wire industry started in the heart of the textile area and it increased to such an extent that by 1860 Worcester, Massachusetts, manufactured 58% of the wire made in the United States.

As the textile industry developed and advanced towards large-scale production, iron replaced wood in the machines. Accordingly, the growth of cotton and wool manufactures was accompanied by an increase in foundries and machine-shops. These, in turn, pressed the iron manufacturers for more pig and bar iron. In like manner, the demand for internal improvements, such

as turnpikes or canals, sent its pulse back to the fires that smelted iron. These improvements called for iron in the construction of coaches or boats, and even the horses that towed the boats were shod with iron. The largest water wheel in the United States was built at the Burden works at Troy, New York, to run three rolling-mills that turned out iron shoes for the horses that towed the barges of the Erie Canal.

In short, every step toward the subjugation of the physical environment, every movement toward a more rounded civilization, tended to enhance the importance of iron manufacture. Inasmuch as the East was the manufacturing, commercial, political and social center of the new nation, it was there that the need for iron was keenest. Consequently, the greatest quantity of iron was produced in the East.

Technical Improvements.—To meet the requirements of the market in both West and East, technical improvements in iron-making apparatus were required. The old forge, in which ore was piled upon an open, charcoal-filled hearth fanned by a gentle cold current of air squeezed from a hand-operated Catalan bellows, was inadequate and was gradually changed to a better device. In 1750 water power was applied to strengthen the force of the draft and wooden bellows took the place of the Catalan. The better draft permitted a higher furnace, and this turned out more product. The Lynn furnace of 1642, one of the best of its time either in America or England, had an output of 8 tons a week. In 1788 the progress with draft and taller stacks permitted a production of 15½ tons a week.

The next step was taken in England in 1784 when Cort invented the puddling furnace and the grooved roll. Previous to this time all iron was purified by hammering with sledges. Cort's puddling furnace took pig iron upon a shallow saucer-like hearth where the iron melted. It was then stirred until nearly all impurities were removed. Essential to the process was a furnace lining of iron-oxide. The oxygen of this lining combined with the carbon of the pig iron, and the compound (carbon-monoxide or carbon-dioxide) escaped in gaseous form. That is, whereas the previous method of purification had been physical, Cort substituted

in part a chemical cleansing. Furthermore, as the heating of Cort's furnace was indirect, it permitted the use of fuels other than charcoal, which had become startlingly scarce in England.

When ready, the iron was carried to the second invention—the grooved rolls—and there was twisted, turned, and squeezed until it was pure enough to use. The resultant iron was fibrous and tough and therefore fitted for all purposes where strength was a desirable quality. All other needs were met by melting pig iron and pouring it into moulds.

The final measure, taken before 1830 to insure a supply of iron, was a Scotch invention whereby the draft was heated before its entrance to the furnace, thus saving fuel, and, at the same time, raising the temperature of the furnace. John Campbell was the first American to provide an iron furnace with a hot blast, as he was also the first to use the waste gases from the furnace to run boilers. Thomas W. Means, son of John Means, equipped the Union Furnace with a hot blast as early as 1828, probably the second installation in America of that Scotch invention. As a result of the new ideas the Americans brought their product up to 35 tons a week.

Railroads Influence on Iron Manufacture.—By 1830 the iron industry had attained this stage of mechanical perfection adjusted to the needs of consumers. Yet, while it is true that the industrial expansion of the East was reflected in the progress of iron manufacture, nevertheless, by comparison with later events, the earlier iron trade was a small affair. The one factor of all others that has placed the iron industry of America before all competitors in the world is the railroad. Railroads have been the greatest consumers of iron within the history of that commodity.

In 1830 there were 23 miles of railway in the United States, but during the next ten years nearly 3,000 miles (2,810) were laid down. All of this activity was confined to the Atlantic coast with Philadelphia as the principal radial center. Between 1840 and 1850 no less than 6,000 miles of trackage was built, for the most part in New England.

These facts had an important bearing on the iron industry,

for they stimulated the American makers to feverish activity. Despite larger furnaces and improved processes, production lagged far behind demand, and the first railways were largely equipped from foreign sources. For example, the Philadelphia and Reading Railroad in 1844 advertised for months for 8,300 tons of T-rails without receiving a single American bid and finally imported the rails from England, although the British rails had to pay a tariff duty imposed in 1842 to stimulate American production. In 1850, 60% of America's iron consumption was imported. It was not until about 1880 that the United States overtook and passed the production of Great Britain. In 1926, when the world's output of steel was 89½ million tons, the United States produced 54%.

Not only the railways themselves, but all the manufacturing enterprises that the new transportation agent encouraged, put a greater and greater strain upon our iron industry. In its headlong effort to keep abreast of its market, furnaces were enlarged, new fuels tried out, and a new region chosen as a manufacturing center where both raw materials and markets were within easy reach.

Railroads did not immediately influence the iron industry, because iron at first formed so small a part of a railroad's equipment. The frames of locomotives, the coaches, and even some rails, were made of wood. Iron entered into railway construction and rolling stock only for wheels, axles, springs, and the small parts of the engine. All the producing centers—Massachusetts, Connecticut, New York, and Pennsylvania—contributed a share of these necessities. Gradually, iron replaced wood in locomotive frames and iron straps fastened to wood or stone constituted the rails. Parts of the New York Central retained these rails until 1850, and in the South they were familiar even ten years later. Loose straps were a frequent cause of accident, for they rammed through the floors of the fragile wooden cars, maimed or killed the passengers, and often ditched the whole train. Solid iron rails were adopted to remedy the evil, but none were manufactured in this country until 1844. In that year a mill was erected in Maryland for the express purpose of rolling heavy iron rails and it was followed the next year by another new rolling-mill at Danville, Pennsylvania. These two may be said to have inaugurated the

modern expansion of the iron industry in response to railroad influences.

Anthracite Furnaces.—So long as furnaces were small, charcoal was the most desirable fuel because it made the purest iron, but a large furnace required so much fuel that the surrounding wood was soon exhausted. It took from 250 to 360 bushels of charcoal to produce a ton of iron. Thus, if all the iron of 1850, for example, had been produced by charcoal, it would have consumed 46,000 acres of forest. On the other hand, 200 acres of 4-foot coal could do the same work. A moderate-sized furnace necessitated a wood reserve of 4 square miles, while to carry charcoal from a distance added prohibitively to the cost of production. Since the little 15- and 20-foot furnaces of 1830 were utterly inadequate to produce the iron needed by railways and factories, the height went to 25, 30 and 45 feet, with a diameter of 12 feet. With increasing height, the scramble for fuel became even more vigorous until the need for a substitute for charcoal was imperative.

Soft coal generally was not strong enough to bear the burden of the ore, although in Ohio a furnace 55 feet high and 16 feet in diameter, produced 1,600 tons of iron a month with raw bituminous fuel. Distilled soft coal in the form of coke was then unknown in the United States. There remained but one other available substitute for charcoal, namely anthracite, which had been used in a minor way in connection with iron rolling since 1812. After much disappointing experiment anthracite at last was employed successfully for smelting iron.

The first plant to manufacture iron commercially with anthracite was the Lehigh Crane Ironworks of Catasauqua, Pennsylvania. David Thomas, a Welchman, who was superintendent of this company, is credited with founding the American anthracite iron industry. In 1840, before the rolling of iron rails began, there were only six anthracite furnaces in all the United States, but by 1856 there were 121, and for twenty years thereafter (1855-1875) anthracite was regarded as the principal iron smelting fuel. The most famous of the iron manufacturing companies that used anthracite fuel was the Lackawanna, whose original

plant was located directly over anthracite coal mines at Scranton, Pennsylvania. This company now is located at Buffalo, New York.

Advantages of Anthracite Region.—As everyone knows, the anthracite fields are in eastern Pennsylvania about equidistant from Philadelphia and New York and in a region where iron ore was plentiful. Connected to the seaboard by canals and railroads, the area was admirably situated to support an iron industry, because it had both the requisite raw materials and access to the greatest market.

In the ten years following 1850, the New York Central extended its lines to Buffalo by way of Albany, the Erie Railroad connected New York City with Lake Erie at Dunkirk, the Baltimore and Ohio reached the Ohio River, and the Pennsylvania joined Pittsburgh to Philadelphia. Here was a circle of railway-building around the anthracite coal fields that helped to push railway mileage from 9,020 miles in 1850, to 30,626 miles within the next ten years. It is easy to see, therefore, why the Schuylkill Valley, the Lehigh Valley, the Susquehanna, and the Juniata were the seats of the iron industry of that period. Among the towns of this region to become famous for iron manufacture were Reading, Harrisburg, Phoenixville, Steelton, South Bethlehem, Danville, Pottstown and Lebanon. They have retained their fame to the present day.

Furnace Capacity.—With a voracious domestic market the American iron industry strained under the pressure put upon it and sought to adjust itself to the fast increasing needs. Greater output was the immediate prime necessity, and under this lash startling advances were made in mechanism. Furnaces that were 45 feet high in 1859 were replaced by 75-foot stacks in 1872, whereat the world stood agape; but even these were not adequate, for by the time the century closed furnaces 110 feet high had been erected. Along with increased height the furnaces were given larger girth. The furnace capacity was thus multiplied many times by the enhancement of its dimensions and this capacity was further added to by efficient management.

Coke.—The larger furnaces magnified the difficulties inherent in anthracite as a fuel. Among these were its wastefulness of draft, and its crushing or matting under heavy loads of ore, thus limiting the height of furnaces. The air in anthracite furnaces was under a pressure of 7 to 10 pounds. The Lucy furnace of Pittsburgh using coke in 1870, had a draft of 8 to 9 pounds, but whereas the anthracite furnaces were 55 feet high and produced 200 to 300 tons a week, the Lucy furnace was 75 feet high and turned out 700 tons a week. Other difficulties of anthracite were its comparatively high percentage of non-combustible, non-heating elements, its lack of uniformity, and its increasing price.

A careful search was instituted for a more ideal fuel and after investigation, experiment, and failure, at last success was attained with coke, the carbon residue of bituminous coal that has been heated without combustion, and whose volatile gases have been eliminated. Coke had been known in England since 1740, at which time English charcoal was almost exhausted, but its adoption in the United States had been long delayed by the ample supply of charcoal and anthracite. In 1849 there was not one coke oven operating in all Pennsylvania, and even seven years later the state claimed but 21, while there were less than 100 in the whole United States.

The first commercial development of the well-known Connellsville coke, the best in the world, carrying as high as 70% fixed carbon and less than 1% of injurious sulphur or phosphorus, began in 1841, when it was sold in Cincinnati to stove manufacturers and other iron refiners; but coke of any kind then was not popular. In 1855 the Baltimore and Ohio Railroad was completed to Pittsburgh and carried coke to that city where it was employed successfully in the rolling-mills. The real development of Connellsville coke, however, did not begin until 1860 when it was used for smelting iron.

With the adoption of Connellsville coke, the fuel problem for the increasingly large blast furnaces was solved; for Connellsville coke burned easily, was strong enough to bear the burden of ore, had great heat, and added few impurities of its own to the iron. From 1860 onward, coke began to displace anthracite and by 1875 had taken the lead as an iron smelting fuel, a position it

has held from that time to this. At present scarcely any anthracite furnaces are in operation and in some years none at all.

Lake Superior Ore.—Larger furnaces and better fuel called for a greater amount of high-grade ore than was being worked when the expansion of the market began. The ores near the existing blast furnaces were either largely exhausted, or low grade, or difficult to mine and melt. The most satisfactory ores obtainable were discovered near Lake Superior in the States of Wisconsin and Minnesota. The Sharon Iron Company, Mercer County, Pennsylvania, in 1853, imported 152 tons of this ore via Erie, Pennsylvania, purchasing the ore from the Cleveland Iron Mining Company. The excellence of the ore attracted the attention of iron masters all over the state. The Sault Canal was opened in 1855 and regular shipments of Superior ore began the next year.

At first this ore was mined by the time-honored method of shafts, gangways, and picks. But in the early nineties it was found that the deposits lay near enough to the surface to use the "strip" method of mining familiar in certain coal fields. The earliest stripping was done by horse scrapers, and the ore shovelled into horse drawn carts. It was carried across the Lakes in small 20-ton boats. These slow, laborious arrangements were not in keeping with the quick stepping iron industry with its everlasting cry for more tonnage, so a special type of steam shovel was devised that would bite into, scrape and scoop the ore. The first shovels weighed 35 tons and picked up one ton of ore at a swoop. As even this great improvement over former practice was insufficient, bigger shovels were put to work. Eventually, the shovels weighed 300 tons; they grabbed 16 tons of ore at each lift and 100 tons in an hour.

The ore was dumped, not into wagons, but into railway cars which when filled were made into trains and hauled by the biggest of locomotives over the best of tracks to the docks at Duluth. About 30 such trains of 96 cars each was the schedule per day. At Duluth the ore dropped by gravity into specially designed ore carriers, first the "whale back" and then the modern vessel, which is nothing but a glorified canal barge capable of transporting from 10,000 to 14,000 tons, which is loaded in less than half an hour.

At the lower lake port the vessels were unloaded by marvelously expeditious machines, which made it possible to clear a boat in from three to five hours and start it back to Duluth. During the eight months open to navigation these boats passed in a steady procession back and forth across the Lakes.

The largest open-pit mine is the Hull-Rust, a gash two and one-quarter miles long, three-quarters of a mile wide and 300 to 400 feet deep. From it in one year as much as 7 million tons of ore have been shipped. It may be remarked that in laying bare the Lake Superior deposits, more dirt by a million cubic yards has been removed than was dug to construct the Panama Canal.

The Hearth of the Nation.—The quantitative mining of the high-grade Lake Superior ore and the shift from anthracite to coke that accompanied the increased size of furnaces could not well avoid bringing about a change in the localization of the industry, since the new ore and new fuel were not found near the established furnaces. Hence the greater furnaces that arose to utilize the new materials were set up in new centers more strategically located. The place that was most admirably adapted to reap all the advantages of the changed conditions was Pittsburgh.

Pittsburgh lay half-way between the extremes of the eastern and western market; it had excellent rail connections eastward and both rail and water routes to the west and south, and since after 1860 the principal railway construction was in the states immediately west of the city, Pittsburgh was nearer to the point of greatest consumption than the older eastern centers. Moreover, Pittsburgh was next door to the best coke in the world; Lake Superior ore could reach it easily and cheaply; it had a long-established rolling-mill industry—in 1856 there were 35 rolling-mills in Pittsburgh and Allegheny—and, lastly, it was already organized to market iron products. Inasmuch as no other place possessed such a combination of attractions, Pittsburgh became the hearth of the nation, and from 1859 onward for nearly a half century no American community was so thoroughly identified with all parts of the iron industry as the city that stood at the head of the Ohio River.

CHAPTER IX

STEEL

Cry for Better Iron.—The technical progress that brought Pittsburgh to the fore was in response to the market demand for tonnage. At first the cry had been merely for *more* iron, but as locomotives became larger and more complicated, as trains were longer and heavier, as buildings were higher and machinery more important, the wail was for *better* iron, as well as larger quantities of it. Bridges made of wood or iron sagged and broke under the weight of the increased load; iron rails snapped and spread under the pound and thrust of heavier, faster locomotives and the burden of larger cars. Architects needed a new material to build taller buildings. Everybody, seemingly, was dissatisfied with the quality of iron.

Steel.—Steel fulfilled the universal craving. Steel differs from iron in the proportion and accuracy of mixture of its components. Its exact definition is difficult, for the carbon content varies over wide limits according to the use made of the steel. Special steels also contain other constituents such as chromium, manganese, nickel, tungsten or vanadium.

Steel was as well known to iron makers as iron itself, and had been manufactured in small quantities since the dawn of history. It had been used, however, only for the finest and most costly articles, such as high-grade cutlery, because it was so expensive to manufacture. The purest charcoal fuel and the most selected ore were necessary for the pig iron that made steel. The pig iron was hammered into bars and these were packed into boxes between layers of charcoal and brought slowly to a high heat in a retort that resembled a lime-burner. After weeks of watching and testing, the bars were removed, having been transformed from iron to steel through the absorption of carbon from the charcoal.

The risk of failure in this process was high, and even at best the product was never uniform; a standard material for cutlery, for instance, was only to be obtained by carefully sorting the steel bars, combining and rolling together the proper ones, and then re-sorting and recombining. Obviously, steel so laboriously, lengthily, and expensively produced could not be made into rails, bridges, or skyscrapers; one might as well use diamonds for curbstones. The world needed abundant cheap steel; how to get it was the problem.

Bessemer Process.—The riddle was solved in England in 1855 by Sir Henry Bessemer. He poured fifteen tons of molten pig iron into a movable pear-shaped retort called a “converter,” and then blew hot air through the mass for about twenty minutes. The oxygen of the air combined with the carbon of the pig iron, the gaseous product (carbon monoxide) passing out of the converter and burning at the mouth of the vessel in a spitting, sparkling, roaring flame. When all the carbon was gone, a definite measured amount was restored to the iron. When the melted mass was poured it was no longer iron, but steel.

The Kelly Patents.—This process of steel-making gave the world what it wanted; steel made in thirty minutes, not three months; steel little more expensive than iron; steel many times stronger than iron. But the United States had to wait eight years before it could use this great industrial boon; lawsuits stood in the path of progress.

In 1856 when Bessemer tried to patent his process in the United States he found that a William Kelly had made an independent discovery of the same idea and that Kelly claimed priority, a claim that was sustained. Although Kelly obtained his patent monopoly he was never successful in producing steel, because his machine seemingly was not so good as Bessemer's. An essential part of the process used by both Bessemer and Kelly was the addition of a known quantity of carbon to the purified pig iron and this step was controlled by British patents issued to Robert Mushet, the originator of the method. It consists in the use of spiegeleisen. This is a name given to an alloy of iron

and manganese with a known amount of carbon. It contains from 10% to 20% of manganese which combines with and removes dissolved oxygen which otherwise would produce blow holes in the steel. The known carbon is what changes the iron to steel. The Kelly group obtained the monopoly of this process in the United States, so for some time matters stood at a draw. The Troy, New York, men who controlled the Bessemer interests in the United States could not operate without infringing upon the Kelly right to the use of spiegeleisen. On the other hand, Kelly could not produce steel because his machine was not as good as Bessemer's, and he could not improve his machine without infringing the Bessemer patents.

Naturally, the two contestants were forced to consolidate, the event occurring in 1866, the new organization being named, The Pneumatic Steel Company. This company licensed others to use its process. Fees and royalties were reduced in consequence and America began a belated use of the much-sought steel. Kelly's first converter stands as a monument in front of the offices of the Cambria Steel Company, Johnstown, Pennsylvania. On the walls of the public library of Wyandotte, Michigan, which is placed on the site of the Wyandotte Iron Works, in which Kelly's first tilting converter was operated, there is a plaque commemorating Kelly and his converter.

A. L. Holley: Introducer of Bessemer Process.—Alexander Lyman Holley is credited with introducing the Bessemer process to America. He had been sent to England in 1863 by Corning Winslow and Company of Troy, New York, to learn the Bessemer method. He brought home with him the purchased rights to use the Bessemer process in America. After the Kelly controversy was settled Holley erected the first Bessemer works in this country at Troy and later made many improvements in the process. Holley's second installation of Bessemer converters was at the plant of the Pennsylvania Steel Company near Harrisburg, Pennsylvania. There, in 1867, steel was poured which was rolled into the first steel rails manufactured in the United States, the Cambria Iron Company doing the rolling. Subsequently, Holley had charge of the erection of many other Bessemer plants.

Bessemer Output.—The popularity of the new steel was great and its application rapidly extended until steel supplanted iron for most of the important uses. The price of steel fell from \$106 a ton to \$17. In 1875 the Bessemer output was 375,517 tons of which 290,863 tons were for rails. In 1880 the rails alone were 954,400 tons and in 1902 had reached 3,000,000 tons. Springs, car axles, plow shares, stove pipe, and a host of other things were made from steel. A faint conception of the value of Bessemer's contribution may be gained from the statement that one Bessemer rail would outwear twenty iron ones. The age of steel in American industry was one with an extraordinarily brief infancy; it attained maturity within a decade.

Open-Hearth.—After twenty-five years in the use of Bessemer steel, demands of the market caused Bessemer steel to be as severely criticized as iron had been in 1855. The same complaints arose from similar sources; Bessemer steel was too weak for the work it had to do. Bessemer rails were crushed, torn asunder, twisted out of shape, ground away by friction and pulverized by pounding wheels. Again, the market cried for a better material, and again it was forthcoming.

Bessemer steel, manufactured in half an hour, was cheap, but that very inexpensiveness was purchased at the price of accuracy and definiteness in the proportioning of the iron and carbon that determined the steel. An iron master could never guarantee the content of his Bessemer steel. Fortunately, there was another kind of steel known as "open-hearth," manufactured by a slower and more costly method, that produced a high-grade product and one that could be warranted.

This steel was manufactured much as a good cook made soup, for it was tested in a chemical laboratory while making, just as a cook dips out a spoonful of soup to taste its flavor. Although it took from six to eight hours to produce open-hearth steel, its content was known with certainty. In addition, greater quantities could be made at once—50 to 125 tons instead of 15, as in a Bessemer converter—and a wider range of materials and products was possible. The average capacity of an open-hearth furnace

was 60-75 tons per heat but furnaces as small as 5 tons and as large as 125 tons are in use.

Open-hearth steel was manufactured in England and in the United States as early as Bessemer, but because of its greater cost and higher quality, it did not compete in the same market with Bessemer. By 1897 however, when railroads and structural engineers found that they must use a better steel than Bessemer, they turned to open-hearth. Between 1899 and 1904 the amount of open-hearth steel used for rails surpassed that made by the Bessemer process, and at present the number and tonnage of rails made from Bessemer steel is of small consequence, less than 1% of the entire production of rails. Of the total output of steel, scarcely 25% is Bessemer. Indeed the Bessemer process is now often but one step in the production of open-hearth, for by combining the two methods the time necessary for the production of open-hearth is decreased a third and necessarily the cost is lowered.

Electric Steel.—Although the requisition of electricity both for power and metallurgy about a steel works is sixty years old it was not until after 1890 that Americans generally applied electricity to power, and a quarter of a century still later before it was used to heat furnaces. Its use was an indirect consequence of economies in the production of coke and the use of blast furnace gas.

The early manufacturing methods were extraordinarily wasteful, for coke was made by the beehive process in which all by-products were lost, and the ovens were at coal mines, not blast furnaces. The gases of the blast furnaces, too, escaped to the air unused. The by-product coke oven was introduced into steel plants by the Lackawanna Steel Company in 1902 at the Buffalo works, an example that eventually was followed by other steel makers. The gas from the coking operation ran internal combustion engines, some of which were connected to dynamos. Likewise, blast furnace gas had been captured and at first employed merely to preheat the air blast entering the furnace, but later it was carried beyond the preheating "stoves" to power houses. There, for a while it fired steam engine boilers, but soon

was turned directly into power in gas engines. Some of these also, after 1890, were connected to dynamos.

Electric power, therefore, was derived as a by-product from ovens and furnaces. This power, except for operating cranes and travelling tables, was an auxiliary in odd places about American steel works for years before it was considered as a possible source of furnace heat. The Germans were the original exploiters of electric furnaces, starting their experiments in 1898. By 1913 they were producing 88,881 tons of electric steel, which small amount then was about half of the world's production. At that time we had 19 electric furnaces, all of them of 20 tons capacity or less. The pressure of the World War upon the steel industry and the proven virtues of the electric furnace in the production of certain high grades of steel caused Americans to show special favor to electric furnaces. Each year from 1915 onward recorded the installation of a score or more electric furnaces, the banner year being 1917 when 97 were put in place.

On January 1, 1927, America had approximately 500 electric furnaces. The largest furnaces had been of 80 tons capacity, installed and operated at the Naval Ordnance Plant at Charleston, West Virginia, but this plant was closed in 1922. All of the American furnaces were of relatively small capacity up to 1927, but, whereas in 1913 our electric steel output was 18% of the world's, in 1925 it accounted for 55% of the world's production. This, a record year in American electro-steel, saw our output at 615,000 tons.

An electric furnace is capable of using scrap; indeed, some electric furnaces have yielded high-grade steel into which no virgin metal at all was introduced in the charge. Moreover, furnaces of this type permit perfect control of temperatures, and chemical reactions are uniform in operation and are free from injurious gases and dirt. Chemical metallurgy that is impossible in other furnaces is practicable in electric furnaces.

The Place of the Electric Steel Furnace.—As yet, the electric furnace has not been a competitor of the blast furnace. To be sure, during the World War some pig iron was produced in America in electric furnaces as well as in Sweden, Norway, France

and Italy. After the war the Europeans continued to make small amounts of pig iron electrically, but we ceased. The deterrent to us was the cost of electric current. The same factor prevented the electric furnaces from usurping the functions of Bessemer converters or open-hearth furnaces, which could produce steel for 33 1/3% less per ton than electric furnaces. Electric power must be greatly reduced in price before electric furnaces can compete against the two older steel machines.

It has been against cupolas (foundries) and crucible steel (tool, ordnance and alloy steels) that the electric furnace has made its great inroads. With respect to these, the electric furnaces show marked superiority because of the control possible over temperature and chemical reactions. Furthermore, in these branches of steel production the electric furnace permits establishments to locate where hydroelectricity is cheap but where coking coal is absent or unduly expensive. For example, electric furnaces have been most popular on the Pacific Coast. This points to a decentralization of the steel industry when electricity is cheap enough to compete with blast furnaces, Bessemer and open-hearths. The superiority of the electric furnace in producing special and alloy steels is significant because it is towards these varieties that there is the most pronounced trend.

Steel from Scrap.—The technical improvements in open-hearth and electric steel have had one especially significant result, the utilization of iron and steel scrap in the production of new steel. Ever since the open-hearth was invented scrap has formed part of the charge of raw materials into it, and the same is true of the electric furnace. The important factor is not merely the use of scrap, but the increasing percentage it bears to the total charge. How much this amounts to may be gleaned from a comparison of the tonnage figures of steel production compared with the tonnage output of pig iron: In 1913 the excess of steel tonnage over pig iron tonnage was 234,000 (31,300,000—30,966,000) but in 1926 the difference was 8,750,000 (48,250,000—39,500,000). In the period of thirteen years after 1913 the excess of steel over pig iron increased by 37 times. This means that new steel contains far less virgin metal and much more scrap than formerly, even al-

lowing for the amount of alloys that go into steel. Consideration for our national resources makes it exceedingly important that new steel be made from old.

Sources of Scrap.—The greatest source of scrap is the steel industry itself, for about half the scrap charged into open-hearth furnaces is accumulated within the works. The railroads are meticulous in gathering all their worn or discarded equipment and selling it to dealers or the steel mills. About 5 million tons of scrap per year are gathered by the railroads. The automotive industry furnishes about the same amount. In addition, dealers in abandoned cars, albeit they sell as many second-hand parts as they can, have to scrap most of the cars, so that about a million cars go to the dump every year. Mills manufacturing machinery and tools preserve the filings, scrapings, edgings, and the like, and start them on the road back to the steel furnace. House-wrecking is a profession which saves for reuse an enormous amount of material, including much iron and steel. The oil and mining industries and agriculture are notable contributors to the scrap pile. Then there are the junk dealers of all classes, from those who buy abandoned railroads to those who pick "tin" cans out of garbage heaps; the iron and steel they collect is returned to the steel plants. The steel mills take all the scrap wherever they can get it.

Some electric furnaces have been charged entirely with scrap, and a few small open-hearth furnaces have repeated this experience. Likewise, some foundry cupolas have furnished steel from a very high proportion of scrap charge. In this path lies national economy and cheaper priced steel.

Stainless Iron and Steel.—The number of varieties of steel is incredible and this number is added to every year. Of all the new steels produced in the last decade perhaps the most potential was that called "stainless," a more accurate name for which is "unstainable." This is a steel with a high percentage of chromium (11% to 14%) which is highly resistant to corrosion by air, vegetable or fruit acids, fresh or salt water.

Iron and steel's greatest enemy always has been rust. The

metal has been lost of course by burial, by sinking to Davy Jones' locker, and by fire, but the waste due to rust is the largest of all. No one knows what annual toll rust has taken, but all estimates are very large. From daily observation everyone knows that iron and steel in exposed places soon rust away unless covered with paint, tin or zinc.

Elwood Haynes of American automobile fame and Brearley, an Englishman, just before the World War discovered, coincidentally, the non-rusting, non-corrosive properties of high chromium steel. During the war all of the output was commandeered for belligerent purposes, but after the Peace of Versailles this new steel was put upon the commercial market. The British, particularly those of Sheffield, were most enthusiastic over the new steel. It was used in Britain and America for cutlery, kitchen utensils, surgical instruments, pump parts, and other purposes.

In 1921 stainless iron was announced. This was really a mild malleable and ductile steel, hence it greatly exceeded in usefulness the more brittle, stainless steel. It already has been applied to many purposes, including automobile hoods, bodies and disc wheels; but the range of its application has been scarcely envisioned.

Doubtless, the future holds more in store for stainless iron and steel than it does for any other variety now known, for stainless steel is not a single steel but a group. What stands in the way of its use at present is its relatively high cost and patent complications. In the United States the leading producers in 1927 were the Ludlum Steel Company, Watervliet, New York, and its licensees; and the American Stainless Steel Company, Pittsburgh, holders of the Haynes-Brearley patents.

Early Individual Plants.—The technological changes in iron and steel manufacture were accompanied by changes in organization, for a widespread market induced large-scale production and this, in turn, paved the way for integration.

The same groups of men that owned rolling-mills in 1860 engaged ten years later in pig iron production, but under different corporate organizations. Likewise, a community of interest but

not a physical connection, still later existed between fuel- and ore-producers on the one hand, and iron-makers on the other. When these separate corporations first started, they had many a desperate struggle to survive, not because a market was lacking, but because it expanded at such a phenomenal pace that the many necessary extensions of plants caused the capital of the promoters to assume fixed forms. How rapidly the capital investment mounted is seen by comparing the figures for 1869, when 121 million dollars was invested in the business, with 1919 when $3\frac{1}{2}$ billion dollars was fixed in plant and equipment. During the decades immediately after 1869 when investment was doubling each ten years, it was an advantage to keep each unit individualized despite the fact that many of the units belonged to the same persons; for as separate organizations, the units could furnish working funds for each other by issuing notes that might be discounted at banks. For example, a furnace company, a rolling-mill, and a bridge plant might all belong to the same set of shareholders but the rolling-mill could issue notes to the furnace company and the bridge plant to the rolling-mill; the notes discounted for cash were so many additions to working capital. This method of keeping each other afloat would be denied to the three corporations if they amalgamated as one complete unit, because a firm could not discount its own notes without some other indorsements.

Integration.—Twenty years after the Civil War, the iron industry had become firmly enough established to eliminate the use of credit in the manner just indicated. As soon as capital was more fluid, the inefficiency of keeping apart related plants became apparent; the intercompany profits and royalties were sources of annoyance and where plants were controlled by a few interested persons holding a majority of the stock, injustices to minority stockholders caused trouble. Therefore, the various parts of the iron industry commenced to coalesce; rolling-mills absorbed furnace companies and amalgamated with fuel-producers. The economy and the consequent control of the market afforded by this practice promoted further integration, and, in consequence, companies reached out for ore fields and then sought ownership of the transportation agencies.

When all the various stages of production from mining of the ore to finished rails, beams, or plates were unified under one authority, there followed an attempt to bring into the combine even the most important secondary producers, such as wire mills, tube factories, and the like. This, in brief, has been the history of the Carnegie companies, the United States Steel Corporation, and, to a less degree, that of smaller aggregations. Big, integrated corporations were a response to national and international markets. An entrepreneur might cope with the simplicity of a narrow market, but a solidly entrenched corporation was necessary where broad, complex markets were concerned.

The United States Steel Corporation.—Prior to 1890 the steel industry was individualized and competitive, although agreements and pools sometimes existed. The beginning of mergers occurred in 1889, when the Illinois Steel Company consolidated three former competitors. This was followed in 1891 by the formation of the Lackawanna Iron and Steel Company, which united the Lackawanna Iron and Coal Company with the Scranton Steel Company. The next year the Colorado Fuel and Iron Company brought together the Colorado Fuel Company and the Colorado Coal and Iron Company. At the same time, a "Wire Trust" was formed and the Carnegie Steel Company (Ltd.), a partnership, integrated the Carnegie plants at Pittsburgh with the Frick Coke Company and, by purchase of a half interest, the Oliver Mining Company. The Carnegie group then was the largest single unit in the iron and steel industry.

Between 1898 and 1900 the whole steel industry underwent radical reorganization, mergers sprouting everywhere, no less than twenty-one large combinations being formed. The total capitalization of these was in excess of 300 million dollars. The result was not order and limitation of competition but unrest and excessive competition. Under the tutelage of the Morgan financial interests there was conceived a behemoth to swallow these struggling giants. Accordingly, in 1901, the United States Steel Corporation with a capitalization over a billion dollars was created to absorb eleven of the largest producers, of which the most important was the Carnegie group. Shortly afterward, the Corporation took over

four more large companies and, in 1907, acquired still another. The United States Steel Corporation then was a completely integrated concern, controlling its own raw materials, transportation agencies, blast furnaces, rolling-mills and fabricating plants. Its position enabled it to establish prices and to prevent extreme fluctuations. For example, the price of steel rails, which had fluctuated violently, was fixed at \$28 per ton from 1902 to 1913. The independents outside the Corporation have always, according to the market, underbid or overbid the Corporation. Among the outstanding independents were Jones and Laughlin, Lackawanna Iron and Steel Company, the Republic Iron and Steel Company, the Pennsylvania Steel Company, the Cambria Steel Company, the Bethlehem Steel Company, and the Colorado Fuel and Iron Company.

Although the promoters of the United States Steel Corporation may have had in mind the establishment of a monopoly, they never secured it. The independents, large and small, outstripped even the remarkable growth and expansion of the Corporation itself. The steel ingot capacity of the Corporation compared with the total national capacity shrank from 66% in 1901 to 45% in 1926. Consequently, when in 1914 the government sought the dissolution of the Corporation on the grounds that it was a monopoly, the suit failed.

Mergers as World War Aftermath.—Although mergers and consolidations went on constantly among the smaller independents between 1900 and 1920, no more significant mergers occurred until after the World War.

This mighty conflict caused a rapid extensive addition to American iron- and steel-producing capacity. The boom that followed the Armistice kept these plants operating at full speed for a brief period, but in 1921 business collapsed. During that distressful year the steel industry ran at 38% capacity, the lowest it ever reached. Rumors then flew thick and fast concerning forthcoming mergers among the chief independents. At that time the leading independent producers were:

1. Bethlehem
2. Inland

3. Midvale Steel and Ordnance
4. Republic
5. Steel and Tube Company of America
6. Youngstown Sheet and Tube Company
7. Brier Hill Steel Company (of Youngstown)
8. Colorado Fuel and Iron Company
9. Jones and Laughlin
10. Lackawanna

The Bethlehem Company had already acquired the Pennsylvania Steel Company (Steelton, near Harrisburg), the Maryland Steel Company (Sparrows Point, near Baltimore), and the Fore River Shipbuilding Corporation (Quincy, Massachusetts). The Inland Steel Company had been organized in 1873 as the Chicago Steel Works and had enjoyed remarkable expansion after 1901. The Midvale Steel and Ordnance Company was a "war baby," born in 1915. The Midvale Steel Company was an old company famous for its armor plate but, so it was said, because the daughters of its president were married, one to an Englishman, the other to a German, the company accepted no European orders for war materials. It was bought by William Ellis Corey (formerly president of the United States Steel Corporation) and associates in 1915 and merged with the Cambria Steel Company, the Remington Arms Company, and Worth Brothers (Coatesville, Pennsylvania), to form the Midvale Steel and Ordnance Company. The Republic Steel Company was formed in 1899, uniting a score or more iron rolling-mills near Chicago, in Alabama and at Youngstown, Ohio. The Steel and Tube Company had plants at Evanston, Illinois; Zanesville, Ohio; Mayville, Wisconsin; Kalamazoo, Michigan and Indiana Harbor. The last named adjoined the works of the Inland Steel Company. The Youngstown Sheet and Tube Company operated in Youngstown, Warren and Niles, that is, in the same towns as the Brier Hill Steel Company. The latter also owned extensive coal, coke and steamship properties. Jones and Laughlin was one of the pioneer independent iron and steel firms in Pittsburgh, manufacturing varied products and was adequately integrated.

North American Steel Corporation.—In 1922, under the financial advice of Kuhn, Loeb and Company, it was proposed to merge the companies listed as 2, 3, 4, 5 and 6, but this effort failed. Another attempt at merger in the same year involved Midvale, Inland, and the Republic, the new company to be known as the North American Steel Corporation. This merger was nearly completed, but dissolved under the hostility of the Federal Trade Commission. There was also a proposal to unite Inland with Jones and Laughlin.

Bethlehem Steel Company.—Then the Bethlehem Steel Company precipitated an amazing coup by purchasing, in July, 1922, the Lackawanna, followed in November by acquiring Midvale Steel and Ordnance. In the latter case the original Midvale plant at Nicetown was excluded from the purchase and the Remington Arms already had been sold, in July, 1922, to the General Electric Company. These, together with its earlier properties, gave the Bethlehem Company plants at Bethlehem, Buffalo, Harrisburg (Steelton), Baltimore (Sparrows Point), Coatesville, Pennsylvania (Worth Bros.), Johnstown, Pennsylvania (Cambria), Lebanon, Pennsylvania, and Quincy, Massachusetts. In short, the Bethlehem Company dominated steel east of Buffalo, manufacturing a great variety of steel products. Besides it possessed ore properties in Cuba, Chile, Pennsylvania, and the Lake Superior region. Coal lands and transportation agencies also were under its control. It was undisputed second to the United States Steel Corporation, being about one-third the size of that combine, but larger than the United States Steel Corporation had been when it was organized.

Youngstown Sheet and Tube Company.—In January, 1923, it was announced that the Youngstown Sheet and Tube Company had taken over the Steel and Tube Company of America (Chicago) and the Brier Hill Company. This merger, too, was solidly intrenched with ore and coal properties and manufactured a variety of steel commodities, but specialized in steel sheets. The merger made this company the largest independent producer of sheets.

As a result of these maneuvers there were three giant

merged integrations, the United States Steel Corporation with 45% of the national steel ingot capacity, the Bethlehem Steel Corporation with 15% and the Youngstown Sheet and Tube Company with 6%, the latter being the largest single producer in in the Middle West except for the United States Steel Corporation. There remained as large independents, the Inland, Republic, Colorado Fuel and Iron Company, and Jones and Laughlin. Besides these four there were about 50 small independent producing companies.

Foreign Combinations.—In Europe the aftermath of the World War had more serious consequences than in America. The political boundaries changed by the Versailles Treaty cut across economic units so that no continental country was self-sufficient in both ore and coal. Germany had a surplus of coal, but lacked ore; France and Luxemburg were long on ore but short on coal; Belgium had plenty of coal and labor but was poor in ore. Allied troops controlled the German Ruhr district and the Saare was a political uncertainty. Great Britain, which had abundant supplies of coal and sufficient ore, of a low grade, however—was torn by domestic problems and prostrated by strikes. Currency difficulties, taxation and war debts upset all of the countries. Europe trembled on the brink of chaos.

It was not until 1926 that European steel-makers were able to make the first move to extricate themselves from their desperate straits. In March of that year an International Steel Rail Association was formed by Great Britain, France, Germany, Belgium and Luxemburg to control output, allocate market and establish quotas of production.

In the fall of that same year, a movement begun months earlier by the Germans culminated in an international Cartel or pool of the iron and steel producers of continental Europe. This pool established quotas of production on all steel products, not merely rails. Included in the Cartel originally were Germany, the Saare, France, Belgium and Luxemburg. Three months after its inauguration Czechoslovakia, Hungary and Austria were admitted. At the inception the British were invited to join the pool but declined. The purpose of the Cartel was to regulate production, dis-

tribution and prices of all iron and steel products. Quotas of production at first were established as follows:

Germany.....	43.18
France	31.19
Belgium.....	11.63
Luxemburg	8.23
The Saare.....	5.77

These quotas underrated Germany and overrated Belgium, but the agreement provided revision of quotas quarterly on the basis of the previous quarter's production. Each producer promised to deposit in the pool \$1 a ton for each ton produced within the quota and \$4 a ton for each ton in excess of the quota. Producers who failed to achieve their quota were to be allotted \$2 a ton for each ton short of the quota.

Pools similar to this were tried in many industries in the United States for a period of forty years but they invariably failed because of individual greed amounting to dishonesty. On the other hand, the Germans enjoyed long years of success with similar pools within Germany. Unfortunately for the members, the international steel pool followed the precedent of America and not Germany. In 1927 it appeared that either the pool would be abandoned or converted into a sales organization.

Effects of the Cartel.—In Europe, this pool was more significant politically, as an indication of reestablishment of cordial international relations, than it was economically. In America, the pool might have been construed as a threat to our steel industry. In 1926, however, the combined output of the eight member nations of the Cartel was 29,834,835 metric tons or 33% of the world's output. America that year produced 49,006,641 metric tons or 55% of the world's steel. Nor did the exclusion of American steel from European markets directly disturb our iron masters, for our steel exports to Europe always were slight. To us the significance of the pool lay in the possibility of its dumping excess steel at cut prices in our markets in Canada, Japan or South America. Since the pool excluded Britain also from the continent, it might have driven the British to make up this loss by underselling us in the foreign markets we considered ours. Notwith-

standing that only 5% to 7% of our steel production is sold abroad, either one of the steps indicated would be vital to us because often in the rather loose language of the industry, "it has been the last fractional part of our production that yielded the profit." In other words, our mills must operate close to capacity in order to have earnings exceed costs.

The World War.—Going back of these latest mergers and pools that were a result of the World War, there are other features of the war period worthy of comment. The declaration of war late in 1914 brought to stagnation a year that was already a poor one for the American steel makers. This was a breathing period preparatory to six years of breathless effort to keep pace with war needs. War orders began to pour into American mills in 1915 until all were working at capacity. The following year our pig iron production was the largest recorded to that date and the same was true of steel ingot output in 1917. To care for war orders—for the war was largely one of the Allies' steel against the steel of the Central Powers—a great expansion of plants took place. Many new blast furnaces were blown in and scores of new open-hearth furnaces were constructed. The only limitations upon production to full-expanded capacities were difficulties in securing coal for coke, and assignments of cars from the grievously burdened railroads. After we ourselves entered the war the demands for ship steel were piled upon the augmented and pressing needs for ordnance. The federal war government practically dictated the operation of the country's steel capacity.

Naturally, the prices of steel products bounded during this war era. For example, Bessemer pig iron at Pittsburgh normally had ranged around \$18 per ton prior to the war. It rose to \$23.90 in 1916, \$43.64 in 1917, \$31.09 in 1919, and \$44.39 in 1920, the high point. Likewise, steel rails which for eleven years had been stabilized at \$28 per ton advanced to \$30, then \$34, and reached \$57 in 1918. All other iron and steel prices showed a similar ballooning.

Aftermath.—During the war some doubted our ability to keep our increased capacity at work after the war was over. But

most men optimistically claimed that the world would be woefully short of steel as a result of six years of absorption of output in war needs, so that the mills could run indefinitely in taking up this slack. These roseate predictions were temporarily correct so far as the United States was concerned, but were badly mistaken as to the rest of the world. Following the Armistice there set in a boom in American business that lasted through 1920, and carried prices, including those for steel, to new high levels. The reaction came in 1921. That year the steel mills operated at 38% capacity, an unheard of condition. Steel prices dropped although they did not go back to the 1913 levels. For two years the steel industry was so dull that no additions were made to plants and some capacity was reduced. The recovery began in 1923 and accelerated for the next three years, so that the year 1926 witnessed new high records both for pig iron and steel. After five years of operation far below capacity—a condition never known before the World War—the consuming demands of the country fairly overtook the steel production capacity. In that year an investigation by the American Steel Institute revealed that our pig iron capacity was 45 to 50 million tons yearly and steel ingot capacity was 50 to 56 million tons. Easily, we could produce about half the pig iron and steel of the whole world.

The 12-Hour Day.—At least indirectly connected with the World War was the great strike of steel workers in 1919. Before the early era of mergers, unions were common in steel works; but when the Carnegie Company broke the Homestead strike in 1892 it declared against unions. This policy was followed by other steel makers, and shortly afterwards when the United States Steel Corporation was organized its labor policy was frankly antagonistic to unions. This corporation and the large independents were so powerful that unions were unable to combat them. The strike of 1919 was a second great test of the issue between the unions, which had waxed lustily during the war years, and the puissant corporations that made steel. The strike was marked by bitterness and violence. Samuel Gompers, president of the American Federation of Labor, attempted to drag the issue

before an Industrial Conference called by President Wilson. But the strike failed.

Nevertheless, public sympathy rested with the strikers, especially in their demand that the 8-hour day be substituted for the 12-hour day then common in steel works. An investigation made by an inter-church body scathingly condemned the 12-hour day, and other investigations bore out the main points of the inter-church report.

The spokesmen for the steel companies showed that the 12-hour day was not universal, that it was least in vogue in the open-hearth department (50%), more general around blast furnaces (63%), and most common in the Bessemer plants (75%). They also pointed out that the work where 12 hours prevailed was intermittent in intensity and that the men loafed or slept with the unofficial sanction of foremen on time for which they were paid. It was assumed by these protagonists that the nature of the processes in the steel industry was unique and demanded 12-hour shifts. They asserted that a three shift 8-hour program was too costly to consider.

The antagonists of the 12-hour day found that in the forty continuous process industries of the United States the 8-hour day was favored over the 12, except in the steel industry. They also claimed that a 48-hour week (or even less) was generally accepted in non-continuous process industries. They argued that an 8-hour day in steel would produce more alert men, better morale, and win public approval. As for the intermittency of the tasks, these champions of labor asserted that was of less consequence than the time a worker had at home with his family. The cost of the change would be—so it was said—only from 3% to 15% and this was actually less than the differences in costs that already existed between different steel plants. Moreover, the cost could be reduced by the installation of more labor saving devices.

The debate in the public press ran so hot that President Harding called the steel magnates to a conference at the White House in May, 1922. As a result, a committee of steel makers was formed to seek information as to the feasibility of an 8-hour day. This committee's report was adverse. A year later the American Steel

Institute composed of steel manufacturers made a tentative gesture toward a shorter day. President Harding published a letter urging the Institute to weigh carefully all the evidence and to hasten, so far as possible, the abolition of the long work-period. On August 16, 1923, the Carnegie Company of Pittsburgh announced its adoption of the 8-hour day. The other principal steel producers immediately fell in line and the 8-hour day became the standard for the steel industry. In reality, this was a victory for public opinion, an elusive thing, but more powerful than the steel corporations.

Decentralization of Steel Manufacture in Accord with Decentralized Market.—We have seen that the iron and steel industry during most of its life has had at each time one prominent center of production. First, it was in eastern Massachusetts, then Salisbury and Lancaster, later, in the anthracite coal region and, latterly, at Pittsburgh. Since 1900, however, this rule has been breaking down, for during the last quarter century the steel industry constantly has tended toward decentralization.

The age of great railway construction has passed; indeed, our railway mileage is shrinking rather than expanding. Although the railroads in demanding cars, locomotives, rail replacements, bridges and other equipment are still the best customers of the steel mills, their standing as such has suffered a relative decline. Rail orders are for replacements, not new line; railway equipment orders bulk larger in the railroad demands on the steel industry. The significance of this change is that while rails are manufactured by steel makers, the railway equipment mills are scattered independently of steel mills and call for shapes, not for finished steel.

As the relative leadership of the railroad buyers has sunk, so, conversely, the importance of other buyers has risen. Among them are the building trades, the mineral industries, including oil and water companies, the automotive industry, agriculture, and food packing. New building is most impressive in the East and Middle West where most of the population lives, but it is advancing most rapidly on the Pacific Coast. Metal mining is a western

institution, while coal mining is carried on in thirty-two states. Petroleum is found in widely separated fields from Pennsylvania to Southern California. Agriculture, while most prominent in the Middle West, is important in the southwest and along the Pacific, nor is it to be minimized in the older East. Food packing stretches from Camden, New Jersey to Alaska. In short, the buyers of steel are scattered over the nation.

Universal Demand.—Although the railroads, the building trades, the mineral industries, and the automotive works normally have taken two-thirds of our annual production of steel, the remaining third has been around 16 million tons, or about as much as Germany, the world's second greatest steel maker, produces yearly in total. For this last third of our output the farmers have been the best customers, farm machinery, tools and wire constituting their chief demands. About equal to the farmers have been the manufacturers of food containers. A "tin" can is a small thing in itself, but the total number of cans is staggering. Along with these two buyers have stood the makers of machinery. Factories are so big and noisy that it is hard to realize that they use no more iron and steel than the other two groups but, as a matter of fact, the farmers actually have bought in most years about a quarter million tons more steel than the manufacturers of machinery, and this is true, also, of the container manufacturers. The miscellaneous buyers of steel are too numerous to classify, yet their aggregate purchases of steel have been greater than all the farmers, food container and machinery makers put together. For that matter, the sales to the automotive industry are only about half as much as the total peddled out in small quantities to a host of users.

The direct markets for steel are influenced by nearly every other activity in the country. In the last analysis, every book that is written or read, every meal that is prepared, every cigarette that is made, almost every demand of every person, is sooner or later reflected in a demand for iron and steel. If the modern America suddenly should be deprived of steel our whole civilization would collapse. Steel, therefore, is in universal demand and the domestic

market for it stretches from the Atlantic to the Pacific and from Canada to Mexico.

Effect of Freight Rates.—Nearness to market is not determined by geographical miles so much as by freight rates per ton mile. With low freight rates one manufacturing center may supply the continent, but when rates advance the practicable shipping distance shortens. This means that high freight rates are conducive to setting up many manufacturing centers each serving contiguous territory. For decades in our earlier history railroad freight rates tended downward, a fact that enabled single manufacturing centers serving the nation to flourish, among them Pittsburgh as lord of the steel industry. But since the opening of the 20th century our railroad freight rates have risen sharply and give no promise of sagging. Upon the basis of rates, therefore, the steel industry should have shown a movement toward decentralization. In fact, this tendency was distinct but was partially offset by a system of selling steel, called the "Pittsburgh Plus."

Evidence of the movement toward decentralization is found in the rise of steel manufacture at Buffalo, Cleveland, Detroit, Gary, South Chicago, Duluth, Pueblo, Birmingham, Baltimore, New York Harbor, and the environs of Boston. Rolling-mills and foundries, but not blast furnaces, appeared on the Pacific Coast.

"Pittsburgh Plus."—Against the tide which was sweeping new construction of steel plants away from the established center at Pittsburgh was interposed selling by "Pittsburgh Plus." A buyer of steel plates in Iowa purchased them from a mill in Chicago, but he paid the price set as if they had been bought from a mill at Pittsburgh and, in addition, paid the freight rate (the "Plus") that would have been assessed against shipment from the Pittsburgh mill, not the smaller charge for the freight from Chicago, where he actually did his buying. This scheme annihilated geographic nearness and had the same effect as if every steel plant were located at Pittsburgh. The idea was promulgated in the financial panic of 1907 and was used until 1924, although not constantly, and not for every variety of iron or steel, nor for every group of customers.

In 1919 the Western Association of Rolled Steel Consumers petitioned the Federal Trade Commission to remove from them the incubus of "Pittsburgh Plus." The Commission held hearings in various places, as a consequence of which it issued in 1921 a complaint against the United States Steel Corporation citing the "Pittsburgh Plus." Upon the complaint more hearings were held during the next two years. The Corporation claimed that the "Pittsburgh Plus" was largely a fiction, that it was merely a convenient way of establishing base prices at one point, that it was not used constantly, and that it seldom harmed any consumer. Nevertheless, the Commission issued, in July, 1923, a ruling that within sixty days the United States Steel Corporation abandon "Pittsburgh Plus." Because of the vigor of its defense before the Commission it was supposed that the Corporation would disregard the ruling and take the matter to the courts. But instead the Corporation on September 18 announced compliance with the order.

Effect of Abolition of "Pittsburgh Plus."—The immediate effect was the lowering of prices on some steel products and flooding with orders the mills in the Chicago steel producing district, together with a slackening of business at Pittsburgh. The Pittsburgh producers, led by Jones and Laughlin and followed by the Steel Corporation, turned to shipments of steel upon the Ohio and Mississippi rivers. Some all-water shipments have been made but, because of the vagaries of the two streams, the usual practice has been a combination of water and rail carriage. This yields a rate that is about 80% of the all-rail rate and thereby extends the competitive area of the Pittsburgh mills. The Colorado Fuel and Iron Company was able to reach eastward as far as Nebraska, a fortunate extension, for it was seriously threatened in its Pacific Coast market by all-water borne steel via the Panama Canal from the Birmingham plant of the Steel Corporation. The abolition of "Pittsburgh Plus," therefore, was conducive to decentralization of the steel industry.

Rise of By-Product Coke.—While the industry centered at Pittsburgh the coke used for fuel was manufactured by the "bee-

hive method," the name referring to the fancied appearance of the ovens. These comprised a row of brick ovens in which charges of 5 or more tons of coal were slowly brought to distillation temperature by the indirect heat from adjoining ovens and from escaping gases which ignited and burned in the dome of the oven. To produce coke—the residual carbon after distillation—required forty-eight to seventy-two hours. The advantage of the process lay in its cheapness and simplicity, and it furnished excellent coke.

The best coal for conversion into coke in the beehive oven was that which was high in carbon. The coal which most admirably fulfilled the requirements was that found around Connellsville, close to Pittsburgh. This gave Pittsburgh a decided superiority over other places in the manufacture of iron and steel, because coke shatters so easily that it cannot be shipped any great distance. It was uneconomic to carry Connellsville coal for beehive coking close to steel plants far from the mines, inasmuch as freight would be paid on heavy weights that were thrown away since the only usable product was the light weight coke. In addition, steel works produce communities of their own, or are located near large cities. The beehive method of coking is extremely dirty and pollutes the neighborhood for miles around the ovens. So long as Connellsville beehive coke was the favored fuel in manufacturing iron and steel no other place was so favorably situated as Pittsburgh.

But the beehive method of coking wasted all the constituents of coal except the residual coke, and even some of that was consumed in the process. The sum of the values of the distillates from coal often have been far more than the value of the coke. That is, the beehive ovens gained a dollar's worth of coke by throwing away two or three dollars' worth of other important products; or put in another way, about 500 possible commodities were destroyed in producing one.

The Germans invented coke ovens in which all the distillates from coal were saved and the actual volume of coke brought closer to the theoretical carbon content of the charged coal. Since the coke was not the sole commodity obtained, coal lower in carbon could be put in the ovens; indeed, two or more varieties of coal,

none of which alone would produce good coke, could be mixed and coke of fair quality derived. Ovens that did this work were called "by-product" as distinguished from "beehive." By-product ovens were much more expensive to install but, obviously, were far more economic in their results.

Among the first iron and steel makers to install by-product coke ovens in connection with blast furnaces, was the Lackawanna, whose Buffalo plant was too far from Connellsville to use beehive coke. This event occurred in 1902, yet steel makers were so conservative that in 1910 barely 20% of all coke was manufactured in by-product ovens. From that year onward the installations of such ovens were so rapid that by 1923 from 65 to 80% of all coke was by-product made. That is, between 1910 and 1923 the respective position of the two types of ovens was reversed. Beehive coke is now considered by steel makers merely as a surplus supply convenient to call upon in periods of peak pig iron production. The doom of beehive ovens is so plainly written that new ovens are not being built. As a consequence, when ovens are burned out they are abandoned and not replaced. This has had the effect of increasing the price of beehive coke, which is a rather curious result for a declining industry, the reason being that the by-product capacity is not yet up to consumptive demand, especially in peaks of iron production. The largest by-product installation is in the Carnegie Works where over 1,000 ovens produced more than 6 million tons of coke per year.

The use of by-product coke has released the steel industry from location in or near Pittsburgh and Connellsville. An iron and steel plant using by-product coke may be erected anywhere within a 300-400 mile radius of any coal mine of fair quality. Where water transport of coal is possible, the distance separating iron making from coal mining may be greater. Of all the factors favoring the decentralization of the iron and steel industry, by-product coking is one of the most momentous.

Influence of Market.—In 1927 the largest consumer of steel was Pennsylvania, which also was the largest producer. If Pennsylvania's consumption is taken as 100, the other large consuming states rank as follows:

2. Illinois.....	64.5
3. Ohio.....	46.
4. Michigan.....	35.5
5. Indiana.....	30.5
6. New York.....	24.5
7. Wisconsin.....	18.
8. New Jersey.....	15.
9. California.....	14.5
1-4 inclusive consume 2-3 of the total	
1-9 inclusive consume 3-4 of the total	

It is evident that decentralization has kept pace with the distribution of consumption, for each of the nine states has steel plants of ample and varied capacity within it or nearby.¹ California, however, lacks blast furnaces, getting its pig iron by water carriage from the East or from new plants projected in Utah. The Baltimore steel works, which expanded seven times in capacity between 1916 and 1926, command the Atlantic seaboard market and have an admirable location for the export market. All of its raw materials may be brought to it by water. The Birmingham plant offsets the paucity of the southern consuming market by shipping steel by water down the Warrior River and Mobile to export markets and to both Atlantic and Pacific coasts. The Pueblo plant serves the intermountain region and reaches beyond both East and West. That is to say, the market, bounded by freight rates per ton mile, still dominates the steel industry.

Export Market.—The American steel industry differs from all others in that it has always depended upon the domestic market. After us, the world's greatest steel producers in the order of precedence are Germany, Great Britain, France, Belgium and Luxemburg. The first two normally have sold abroad from 20 to 50% and sometimes more of their total production, while little Belgium has exported as much as we have. On the contrary, our continental domestic market always has absorbed more than 90% of our output. Differences in area, population and buying power account for this extraordinary situation.

¹ There is a possible fallacy in this illustration. The direct consumers of steel production are fabricating plants and these locate near the steel producers. Thus, undoubtedly, the rank of Pennsylvania as a consumer is due to the magnitude of her steel raw material production. If the steel mills moved the consumers, also, would probably move. In the other states, however, the consumers appeared before the producers and hence bear out our point.

Of our foreign customers for steel Canada has always been the best, with Japan ordinarily a tardy second. Most of the rest of our export has gone to Central and South America. While the *percentage* of our export trade to total production has been relatively fixed, of course, the actual volume of steel shipped out of the country has kept pace with the marked advance in production.

Status of the Steel Industry.—Although the steel industry is one of three leading manufacturing enterprises in the United States, and probably will continue to hold its position for a long time to come, it is not without threat to its supremacy. Once again, the world needs a new metal, one that is as strong or stronger than steel, but one that is much lighter in weight. If this is found outside the realm of steel—for example, if it should be some new alloy of aluminum—the steel industry would be seriously impaired. In this circumstance it would not, of necessity, follow that our great steel industry would be destroyed, but it might have a powerful competitor which could push it into relative obscurity. On the other hand, if the steel industry itself discovers a new, lighter metal the industry will go forward to new and greater heights.

CHAPTER X

THE AUTOMOTIVE INDUSTRY

Introduction.—The 19th century, which saw many of the world's habits broken, and startling revolutions in the modes of production, the manner of living, and mental concepts, witnessed no more striking innovations than took place in the means of land transportation. As the century opened stage coaches were the new vehicles of travel, soon displaced by railroad trains. In cities the horse-drawn cab met competition from horse-cars, cable and electric cars. The latter, eventually, wrestled with the steam railroads for across-country traffic. Contemporaneously, the nation adopted the bicycle as its means for individual joy rides. When the century was drawing to a close the latest land transportation innovation, the automobile, appeared.

Few inventions have had such enthusiastic acceptance as the automobile. In 1895 scarcely 300 cars were owned in the United States, but thirty years later there were 20 million. New York, California, Ohio, Pennsylvania, Michigan, Texas, and Illinois each, in 1926, registered more than a million cars. Since there was then one car for each 6.1 persons in the United States, the whole national population could have been put in automobiles at once. These figures are still changing, as the number of cars in the nation increases about 15% per year.

In 1895, of the 300 cars owned here only four were manufactured in this country. Of the 22 million registered on January 1, 1927, all but an infinitesimal number were manufactured in American plants. The automobile industry sprang from insignificant individual experiments to first place in values produced by all manufacturers. The value of the annual production of automobiles exceeds the value of any other manufactured product. In the history of manufacturing the automotive industry has no parallel.

The First Automobiles.—A gun carriage propelled by a pot-bellied steam engine rumbled over the cobblestones of France in 1769 and smashed into a building. This, the first automobile, was built by Nicholas Joseph Cugnot. An identical machine constructed two years later now has a place of honor in the Conservatoire des Arts and Métiers in Paris. Thirteen years after Cugnot, an Englishman, W. Symington, and the American, Oliver Evans, each built and operated steam highway vehicles. We say these were the first automobiles because we are sure they actually ran under their own mechanical power. Scattered through dusty archives as far back as 1432 are records of earlier self-propelled wagons, carts or floats, but their motive power is shrouded in mystery and is under the suspicion that it was furnished by concealed boys.

At the opening of the 19th century two movements were going on simultaneously; one, the application of Watt's steam engine to vehicles that ran on rails; the other, the building of steam highway coaches. About a dozen different Englishmen designed, constructed and operated a number of steam vehicles of a ponderous road-roller type. They were not intended for individual pleasure, but were commercial coaches for the transportation of as many as fifty passengers and some ran for months on a schedule over an announced route. Since rubber tires were then unknown it is easy to imagine the effect on roads of running over them a several-ton vehicle equipped with metal rimmed or solid metal wheels. Parliament, in 1831, investigated the relative merits of steam omnibuses and rail cars. It discovered that the steam power that would move one ton over a highway would propel twenty tons by rail, and that the road vehicle ruined highways, frightened horses, and threatened the extinction of the horse industry in all its branches. The highways, therefore, were closed to steam omnibuses by a heavily discriminatory tax.

American Steam Automobiles.—In America, not to be outdone by the British, Thomas Blanchard of Springfield, Massachusetts, invented a steam road car in 1825. After this gesture nothing more was accomplished until 1840, when J. K. Fisher built several steam vehicles for highway work in New York.

Shortly afterward Richard Dudgeon, to win a bet, built a steam carriage that was said to have reached a speed of 40 miles an hour.

Between the Civil War and the nineties quite a number of American inventors tried to produce practicable steam vehicles. Among them were James A. and Henry A. House, sewing machine manufacturers, of Bridgeport, Connecticut; S. H. Roper, of Roxbury; Ransom E. Olds, and Henry Ford.

Steam, Gas and Electricity Improvements.—Meanwhile, French, German and American scientists, working unostentatiously and without much thought of the practical consequences of their work, were busy upon motors that finally led to the practical automobile.

The Frenchman, L. Serpollet, a trained mechanical engineer, invented the "flash boiler" wherein water was instantaneously changed to steam, variable by control of the water or the heat intensity of the fire. The road roller steam omnibuses had used coal, wood or charcoal for fuel under their boilers. These fuels were not only dirty but with them it was impossible quickly to vary the heat intensity. Serpollet, in addition to the "flash boiler," introduced petroleum products for fuels. The combination of these two ideas enabled Serpollet to produce a small light steam engine capable of attachment to existing carriages or buggies.

The Germans, Nicholas August Otto and Eugen Langen, benefiting by the experience of a long line of inventors, including the Frenchman, Lenoir, all of whom had endeavored to produce an internal combustion engine, began building four cycle gas engines in 1864 and at last, in 1876, worked out the essential details of the modern motor. The work of Otto and Langen was applied to the field of highway vehicles by Gottlieb Daimler of Stuttgart and Karl Benz of Mannheim, who not only improved the gas engine but introduced better ignition and carburetion.

American scientists, always leaders in the domain of electricity, had been improving the storage battery. By the beginning of the nineties storage batteries had been brought to such a stage that it was possible to use them to propel vehicles.

Three Types of Automobile Motors.—As a result of all this work by scientists, three types of motored vehicles appeared

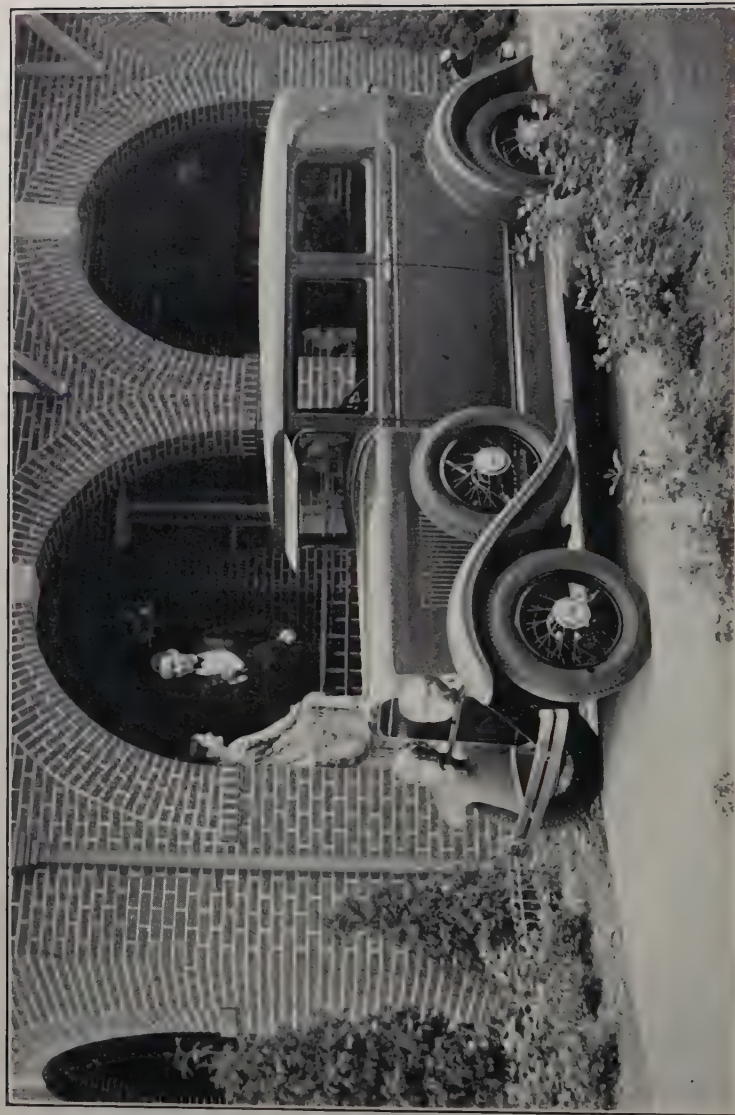
in the nineties. The British, being trained to steam engines of all kinds, grasped the French (Serpellet) ideas, improved the details and put steam automobiles on the market, quite a number being sold in the United States. The French, on the other hand, seized the German gas engine and made it their own. For ten years or more after 1890 the French led the work in the design, production and use of automobiles operated with gas engines. Americans in this period pinned their faith to the carriage operated with storage batteries. Our electric automobiles were the heaviest (2,000 pounds plus), and costliest of early cars, but the electric could be driven by anyone, it was free from vibration, noise and odors, and its repairs were practically non-existent, for it had few mechanical moving parts; some of the first ones are still in use. Because it needed recharging every 300 miles and smooth roads it was limited to cities. Its cost made it the rich man's toy. There would have been no "automobile age" if we had not turned from the electric automobile to the gasoline motor.

Pioneer Producers of Gasoline Cars.—The first Americans prominently identified with automobiles operated by gas engines were Elwood Haynes, Charles E. and Frank Duryea, Alexander Winton and Ransom Eli Olds. Haynes, the Duryeas and Olds built their first cars in 1893—the Haynes car is now on permanent exhibition at the Smithsonian Institution—while Winton came into the market in 1894. It was the Haynes car that got into the Smithsonian but it was the Duryea cars that attracted the most attention at the time they were built. On Thanksgiving Day, 1895, the *Chicago Times-Herald* sponsored an automobile race on a course 54 miles long. The Duryeas' car, the fifth made by these brothers, splashed through mud and slithered through snow to victory in eight hours. A year later, the Duryea Motor Wagon Company, the first gas automobile manufacturers in the United States, produced twelve cars, one of which won a round trip race between New York and Irvington-on-Hudson, and another went on tour as an exhibit with Barnum and Bailey's circus. Alexander Winton, a former bicycle manufacturer, incorporated the Winton Motor Company at Cleveland in 1897, America's second automobile manufacturing establishment. Ransom Olds built the first



(U. S. National Museum, Washington, D. C.)

PLATE 6. The Oldsmobile of 1896. The first commercially successful automobile.



(Courtesy Olds Motor Works, New York Branch.)

PLATE 7. The Oldsmobile of 1929.

three-wheeled horseless carriage in 1887 and a practical four-wheeled automobile in 1893. His first gasoline car was constructed in 1896 and exhibited as an advertised attraction at county fairs throughout the country in 1898 and 1899.

R. E. Olds, Founder.—Haynes is given credit for priority of his gas car, the Duryeas and Winton were the first manufacturers, but the pioneer who did the most to set the United States upon its career as the world's greatest producer and user of gasoline automobiles was R. E. Olds, for he grasped the magic of mass production. Aided financially by retired mining and lumber men of Michigan, he established, in 1900, the Olds Motor Works at Detroit. He designed a light, one-cylinder, curved-dash runabout which could be sold for \$650. Then he dared, in advance of sales, to set a production schedule of 433 cars for 1901, 2,500 for 1902, and 4,000 for 1903. To appreciate the boldness of this schedule one should realize that the total of foreign and domestic cars owned in the United States was only 900 in 1896, 2,100 in 1897, 4,600 in 1898, and 8,624 in 1899. That is, Olds projected in three years the manufacture of one car in numbers about equal to half the existing registration. But fortune favors the audacious; the Oldsmobile was an instantaneous success.

Olds' experience taught that an enormous demand existed for a moderately priced car. His manufacturing policy proved that moderate prices could be obtained by mass production, which gave low production costs per unit. Olds' factory, the largest of its kind at the time, became a training school for a dozen or more young men, every one of whom became a noted figure in the industry in later years. Olds, himself, retired from his own company because his directors refused to sanction the extraordinary lengths to which he wished to carry mass production. Persuaded by his Lansing neighbors and backed by their cash, Olds re-entered automobile manufacturing as head of the Reo Company. It was the Olds policy of mass production of an inexpensive car that carried Henry Ford to fame and fortune.

The Growth of Automobile Manufacturing Plants.—The Oldsmobile was such a conspicuous success between 1901 and

1904, and the sales of the higher priced Cadillac—introduced shortly after the Oldsmobile—were so astounding, that men flocked to the new business. Some in their previous experience bore a logical relationship to the new industry. Many rushed into automobile manufacturing just as they would have swarmed to a new gold field or oil region. Wagon makers like Studebaker or Mitchell; carriage manufacturers, such as Rauch and Lang, or the Columbus Buggy Company; sewing machine manufacturers, of whom the Whites were one; bicycle kings like Alexander Winton, E. R. Thomas, or Colonel Pope, all engaged in the manufacture of automobiles. Also, the Peerless, which was once a producer of clothes wringers, the American Locomotive Company, the Stanley Company, which previously had made photographic dry plates, the Nordyke and Marmon Company, which had an established reputation for flour milling machinery, the Corbin Company, famous for its builders' hardware, all these and many more began to produce automobiles.

The result was the keenest competition. Constant drastic improvements in cars were necessary or failure followed. The fitted and the fortunate survived; the rest perished. Between 1902 and 1907 no less than 322 new automobile companies were inaugurated; in that same period, 287 companies, voluntarily or involuntarily, withdrew from the business. The panic of 1907 cleaned out many weak companies, but 1910 was even more fatal, for during part of that year companies retired at the rate of one a week.

Since that time the number both of new corporations started and of old ones that fail have shown a declining rate. Nevertheless, in 1927 there were barely a score of cars that had been in the market continuously for more than ten years. Those automobile companies that have passed the dangerous age have increased their output remarkably. This industry, common with most others, has evidenced a tendency to reduce the number of individual units by mergers, holding companies, and other forms of business organization.

One measure of the industrial significance of the automobile industry is the fact that two companies, Ford and General Motors,

have a place in the table of the billion-dollar corporations existing in the United States in 1927. This table lists ten companies. Except for the Standard Oil Company of New Jersey, which was not wholly a manufacturing business, and the United States Steel Corporation, the two motor companies were the sole representatives of manufacturing among corporations of the billion-dollar class. The other corporations in this group were the American Telephone and Telegraph Company and five giant railroads. That an industry in its first quarter century of life could push two representatives into such exclusive company is a mark of its amazing growth.

The Ford Motor Company.—The Ford Motor Company was incorporated under the laws of Michigan, June 16, 1903, and capitalized for \$100,000, of which only \$28,000 in cash was actually paid in. There were twelve stockholders, including Henry Ford, who held 25% of the stock. In 1906, Mr. Ford acquired sufficient stock to bring his holdings up to 51%, and shortly thereafter purchased an additional 7½%. This arrangement continued until 1919, when Edsel B. Ford, who succeeded his father as president, purchased the remaining 41½% of outstanding stock. On July 9, 1919, the Ford Motor Company was reorganized under the laws of Delaware, with an authorized capitalization of \$100,000, but its assets have been computed by competent authorities to be worth more than a billion. It is owned entirely by three members of the Ford family.

The principal manufacturing units of the company in and near Detroit normally produced parts for over 8,000 Ford cars and trucks daily. In addition to the Highland Park plant where the general offices were located, there were in the Detroit district the Fordson plant—probably the largest in the world; the Holden Avenue body plant, the engineering Laboratory at Dearborn, and the Lincoln Motor Company, a division of the Ford Motor Company. These units covered a combined area of more than 1,500 acres. Besides these there were smaller manufacturing plants in various parts of the country, six of which were in close proximity to Detroit. Other plants were erected at Iron Mountain, Michigan; Twin Cities, Minnesota; Green Island, New York; Hamil-

ton, Ohio, and Kearney, New Jersey, and also at Glassmere, Pennsylvania; L'Anse, Michigan, and Pequaming, Michigan.

The company, in 1926, had thirty-five branches in the United States, of which thirty-three were assembly plants for the assembling of Ford cars and trucks. It had foreign offices and associate companies in South America, Cuba, Europe, Mexico and Japan. The Ford Motor Company of Canada, Ltd., located in Ford, Ontario, across the river from Detroit, supplied the trade in Canada and the British Empire, except the British Isles.

The Lincoln Motor Company, organized in 1917 to produce motor cars of exceptionally high quality, was acquired by the Ford Motor Company at a receiver's sale February 4, 1922, for \$8,000,000. On March 29, 1922, the Lincoln Motor Company was reorganized in Michigan for an authorized capitalization of \$15,000,000, and thereupon became a division of the Ford Motor Company. The Lincoln plant was greatly improved after it came under Ford ownership. This plant in 1927 had a capacity of 10,500 motor cars yearly, but its actual production was as low as 652 in 1920 and in its best year (1925) barely exceeded 8,000 cars.

The Fordson Coal Company was incorporated in February, 1923, with \$15,000,000 capital, and operated the Company's coal mines in Kentucky and West Virginia. These mines have a coal reserve of approximately 600,000,000 tons.

The Ford railroad, the Detroit, Toledo and Ironton, connects with practically every transcontinental line, which affords unusual shipping facilities. A new division of the road, known as the Detroit and Ironton, 13 $\frac{1}{4}$ miles long and running from Fordson to Flat Rock, Michigan, is operated by electric motive power.

The company also owned and operated lake freighters carrying ore from northern Michigan mines to the Fordson plant and Ford coal north to Duluth on return trips. Other Ford boats operated at sea carrying automobile parts to Ford plants on the Atlantic and Pacific coasts and to foreign ports.

The Stout Metal Airplane Company, a division of the Ford Motor Company, was located at the Ford Airport, Dearborn, Michigan, where the company built all-metal commercial airplanes. Two airlines, one to Chicago and one to Cleveland, were

operated in 1927 with daily round trips on both lines, the airplanes carrying United States mail and company freight.

General Motors.—The General Motors Corporation was organized by Will Durant in 1908. For eight years it was a New Jersey holding company for a line of motor car and motor accessory corporations. After a stormy career the corporation was reorganized in 1916 as a Delaware company with the DuPonts in control instead of Durant. Since that time, while it has functioned in part as a holding company, its principal activity has been that of an actual operating manufacturer. Its stockholders numbered 1,927 in 1917 but were 50,000 in 1927. These were the most fortunate stockholders in the world, for in 1920 and 1926, the corporation's dividends were the largest ever paid except the 1916 war profit dividend of the United States Steel Corporation.

Unlike Ford, who has specialized on one standard model at a time, General Motors has manufactured a line of seven passenger cars, each a leader in its price class. The cars made by General Motors have been Cadillac, LaSalle, Buick, Oldsmobile, Oakland, Pontiac and Chevrolet. It is said that one out of every seven cars produced in America comes from a General Motors plant.

The corporation also has made a line of trucks, beginning with the "G. M. C." and ending with the light truck motored by the Chevrolet. The Yellow Taxicab is another property of the General Motors.

Besides these cars the General Motors in 1927 owned outright or controlled fifteen accessory companies. These made bodies, bearings, radiators, electrical equipments, gears, wheels and sounding devices. Many of these were large scale manufacturing corporations with their own line of subsidiaries. For example, the Fisher Body Corporation operated 44 separate body plants in 13 cities, owned the Ternstedt Manufacturing Company (producer of automobile hardware), the National Plate Glass Company (with four factories and an annual capacity of 30 million square feet of glass), and various lumber operations to supply three sawmills, one of which is accredited the largest hardwood mill in the country.

The manufacturing plants of the General Motors Corpora-

tion in 1927 were located in 36 cities in the United States and Canada. These were directly managed by 28 major divisions and their output was sold by 27 sales organizations. Besides, there was a central laboratory at Detroit, a Research Corporation at Dayton, Ohio, and the General Motors Acceptance Corporation for financing credit sales.

Each of the divisions of the General Motors is largely autonomous and competes not only with the general market but with the other divisions. No division is compelled to purchase from another, not even the accessory divisions. Each does its own advertising but general advertising policies are laid down by the parent organization, which also advertises the whole General Motors "family."

The General Motors Corporation, in 1925, passed Ford in the value of cars produced, but Ford always has led the corporation in number of cars turned out. The two giants came to grips in the low-priced field, where the Ford car sold in competition with the Chevrolet. This competition was carried to Ford so fiercely that, in 1927, he was forced to replace his famous Model T, of which he had made and sold more than 15 million units. The "New Ford" of 1927 was as much a world event as an epochal change of political dynasty. That same year witnessed the General Motors announcement of dividends earned in greater volume than ever recorded by any business organization.

Willys-Overland Company.—The third largest automobile manufacturing company is the Willys-Overland, with headquarters in Toledo, Ohio. John N. Willys originally was a salesman rather than a manufacturer. He had engaged in the retail bicycle business at Canandaigua, New York, in 1890, and later organized the Elmira Arms Company at Elmira. In this city, in 1906, he also formed the American Motor Sales Company in order to engage extensively in the distribution of automobiles. In 1907 this company agreed to market 500 Overland cars.

The Overland car was designed, in 1902, by Claude E. Cox of Terre Haute, Indiana. It had two features radical for its day; one was the placing of the motor in front of the driver's seat instead of underneath the body; the other was a four-cylinder

engine instead of two. Cox induced Charles Minshall of the Standard Wheel Works to manufacture the car. As its sales increased, the manufacture was transferred from Terre Haute to the Indianapolis plant of the Standard Wheel Works. Willys thereupon became general sales agent, guaranteeing to accept and sell a predetermined number of cars. At that time he had no interest in the manufacture of the car.

However, almost as soon as the contract was signed between the Overland manufacturers and the American Motor Sales Company, the panic of 1907 swept the country. Willys had come to the financial assistance of the manufacturers, putting \$11,000 at their disposal. In return, the Overland car was turned over to the Willys-Overland Company, organized for that purpose. The panic being of short duration sales began to swell, with production following suit. The 1907 sales were 383, while the next year the company placed 3,081 cars in the hands of buyers. By May, 1909, more productive capacity was needed, so Willys bought the Toledo plant of the Pope-Toledo Company. That year the company which had worried two years before over a \$11,000 debt cleared a profit of one million dollars.

On November 18, 1912 the present Willys-Overland Company was incorporated in Ohio. It included besides the original company of that name The Federal Motor Works of Indianapolis, the Gramm Motor Truck Company of Lima, Ohio, the Morrow Manufacturing Company of Elmira, New York, the Garford Company of Elyria, Ohio, and the Kinsey Manufacturing Company of Toledo, Ohio. From that day the company has been one of the three leading producers of automobiles and before the General Motors Company was organized was second to the Ford Motor Company. The company has bought very few parts, except wheels, tires and patented articles, one of which, the Auto-Lite, it owns; more than has been customary it has manufactured nearly all the parts of its cars.

Up to 1913 the Willys-Overland Company produced one car of relatively low price. In November of that year it purchased the Edwards-Knight Motor Car Company of Elyria, Ohio. The latter owned the exclusive license for manufacturing in America, Knight sleeve-valve gasoline engine. The Willys-Overland Com-

pany then added the Willys-Knight cars to its line, thus giving the company entrance to the medium and relatively high priced (but not highest priced) field.

In order to take over the Canadian business of the Willys-Overland Company and to promote the sale of Knight engined cars in Canada, the Willys-Overland, Ltd., was organized in December, 1915. This company took over also the Russell Motor Car Company, Ltd., of Toronto. By the end of the next year the Willys-Overland Company had a productive capacity of 300,000 cars per year.

The next step was taken in September, 1918, when the Willys-Overland Company bought control of the Moline Plow Company in order to acquire the latter's tractor. The plants of the Moline Plow Company were located at Moline, Chicago, Rock Island and Freeport, Illinois; Stoughton, Wisconsin; Minneapolis, Minnesota; and Poughkeepsie, New York. In the same year the New Process Gear Corporation of Syracuse was purchased. During the World War the Willys-Overland Company secured the Curtiss Aeroplane Corporation, but this company was relinquished in 1920.

After the war and a serious strike in the American plants of the company in 1920, the Willys-Overland Company combined with the British firm of Crossley's, Ltd., forming the Willys-Overland-Crossley, Ltd., for the manufacture of Overland cars at Manchester, England. Perhaps as a result of this association the American Willys-Overland Company introduced a small European-type car, called the Whippet, to our public in 1925-26. The company, in 1926, made and sold about 200,000 cars in its three lines, Overland, Whippet, and Willys-Knight. Besides these passenger vehicles there was a large production of Garford trucks and Moline tractors.

Taxicabs.—The only business that discovered in the early automobile an economical vehicle was the cab enterprise in cities. The speed, cleanliness and novelty of automobile cabs, contrasted with the hansom pulled by a decrepit beast driven by a weather beaten coachman, made taxicabs immediately and immensely popular. The pioneer taxis were all electric storage battery cars,

and they were so enthusiastically received by the public that soon the taxi business was the largest market for electric vehicles. By 1900 electric taxicabs were common in all our largest cities. After 1901 the gasoline taxicab gradually replaced the slower electric, and within twenty years there were 100,000 taxicabs in the United States. The time-honored "hack" vanished from our eastern streets, save here and there a battered relic. In middle western cities the gasoline taxi was slower to oust the horse-cab because horses, their lodging, food and care, were cheaper than in the East or 'along the Pacific; but even in the Middle West the taxi became ubiquitous. American taxicabs carry approximately $3\frac{1}{2}$ million people per day.

The manufacture of taxicabs was differentiated from other motor car manufacture when the Yellow Cab Company was organized. In 1925 a majority stock control in this company was purchased by the General Motors Company. A dozen other makers have entered upon the production of this type of vehicle.

Commercial Automobiles.—As long as automobiles were confined to the passenger type for personal use they could not exercise their full effect on modern living, nor give assurance to manufacturers that the industry would be permanent. The example of the bicycle was pertinent; this machine for several years was produced in response to popular favor, but when its vogue waned it was the commercial demand that kept bicycle factories in operation. So it was important that a commercial market be found for the automobile.

Since the passenger cars were purchased for personal reasons, the economic factors of cost and comparative performance were of slight consideration. But business men were most interested in these two matters, for economy and efficiency in transportation were the things business men desired. As the first automobiles were neither economical nor efficient compared to contemporary methods of drayage, business executives paid scant heed to commercial automobiles. Prior to 1904 the only use commercial houses had for cars was for advertising. Perhaps the first auto delivery wagon was one built in 1896 for Shepard and Company, a department store of Providence, Rhode Island. This car was

not a mechanical success and it cost more to operate than horse-drawn delivery wagons, but it startled people and attracted notice to the store that owned it. This was its purpose. A few other business houses in direct touch with the public bought commercial cars before 1904 and charged their cost to advertising.

Automobile Trucks.—By 1904 both the automobile manufacturers and the public awoke to the possibilities of auto trucks. The automobile rapidly was becoming a more efficient machine. Business men saw demonstrations which proved that auto trucks expanded trade territory, reduced time in making deliveries, and decreased unit costs of transportation by the increase in volume of goods carried per vehicle per day. The inquiries and orders for trucks caused automobile makers to study commercial cars. The result was not only that many more trucks were offered for sale but that they were better planned for the special commercial services they were called upon to perform.

In 1904 there were 411 trucks manufactured. By 1911 the yearly output reached 10,000, which was about the sum of all made between 1904 and 1910. Within five years 75,000 were made per year and, in 1926, a total of 491,353 were manufactured in twelve months. In that year 27 million trucks were registered in the United States.

While some manufacturers of passenger cars—such as the Reo, Buick, Chevrolet, and Ford—made trucks, there were many concerns which specialized in such production; among them were the Autocar, Federal, Garford, Graham, International, and Mack. About fifty companies in all were engaged in the output of trucks, some producing a whole line of sizes and types, others specializing in a particular size or type.

The Field of the Truck.—Since a motor truck was a means of commercial transportation it came in competition with all other means for doing the same work. That is, it was a rival of horse-drawn vehicles on the one hand, and of steam railroads and electric freight railways on the other. In its formative period motor trucking attempted to supplant nearly all the work of all the other carriers, but experience demonstrated that the motor truck had a special field of operation where its superiority was most marked.

As compared with horses the motor truck was more economical on long hauls, continuous non-stop journeys, or work that involved the movement of exceedingly great weights. In this connection, by long hauls is meant distances over 25 miles but under 100 miles. Frequent stops wasted by idle time the heavy investment in trucks which the cheaper horse vehicle outfit could better withstand. Trucks, on the other hand, moved weights that no number of practicable horse teams could budge.

The story is just the opposite when the motor truck is compared with the steam or electric railways. "Through" freight which means long distance transportation (over 100 miles) was more economically moved by rail than by truck, while local carrying for short distances (less than 100 miles) might be more expeditious and cheaper by truck than by rail. The flexibility of truck transportation was here an advantage. The truck, then, was both a competitor of rails for short haul work and a feeder to the railways for long haul traffic. The railways, after long opposition to the truck, became convinced of its cooperative features, so that some railroads themselves employed trucks for collection, delivery and local services.

For temporary transportation in remote districts, such as lumbering regions, motor trucking often cost less than railroad construction and operation. Likewise, in places where the paying freight was scanty in total volume the motor truck sometimes was superior economically to railways with their high overhead charges.

By defining the field of the motor truck the manufacturers were better able to gauge the market, and to design cars for the work they were expected to do. Moreover, a market analysis was important in deciding upon production schedules which, in turn, influenced manufacturing costs.

The Motor Bus.—The motor bus began about 1910 as the "jitney," an ordinary pleasure car put to the task of carrying paying passengers over a regular route upon an established schedule. The jitney arose in opposition to street railways and suburban or interurban lines. In many places the public had long been irritated against the existing local passenger carriers because of

their monopolistic character, their high-handed treatment of the populace, inadequate service or high fares. Consequently, many people patronized the jitneys in order to "get even" with the other public carriers; others liked the novelty of the newer locomotion, and still others were lured by the greater convenience of jitneys. Overnight the country swarmed with jitneys and on some high-ways they became a pest.

For the most part, the jitney era was short lived. This was due to hostile regulation and to the appearance of the first public auto bus services. The bus carried more passengers than jitneys could and, being designed for the business, transported people in greater comfort than was possible in the helter-skelter jitneys.

But the first busses were no marvels either of beauty or comfort; they were merely motor trucks on which carry-all bodies were mounted. Time and experience have changed this, for engineers have produced busses that throughout were especially designed for the work they had to do. By 1928 the best of them were unequalled in public passenger transportation for speed, comfort, convenience and pleasing appearance.

On January 1, 1927, official estimates placed the number of motor busses in the United States at 80,000. Of these, 42,040 were engaged in common carrier operations, 2,500 being interstate and 7,284 being subsidiary to electric railways. The common carrier busses ran on routes that aggregated 270,000 miles. There were 38,000 engaged in non-common carrier operations, such as hotel busses, sightseeing and tour companies, industrial and school busses, and busses operated in connection with railway terminals.

The Field of the Motor Bus.—A few years ago almost everyone, including electric traction magnates and steam railway officials, thought that the motor bus was a dire threat to the continued existence of rail transportation in local passenger traffic. We now know that the public has need for both bus and rail facilities. Cities such as Akron, Bridgeport, Des Moines and Toledo that once banished electric street railways were forced to bring about their restoration, in some cases as publicly owned utilities.

The place of the bus is on routes that require frequent adjustment, on streets and highways where there is no rail transportation, between points inadequately served by railway lines and in territories yielding traffic too light to support rail facilities.

In 1910 street railways carried their greatest number of passengers in summer on Sundays and holidays. In 1928 their greatest traffic density was in winter on Mondays and Saturdays, or on any stormy day, while their former peak load periods have become their times of greatest idleness. The automobile has caused the change. That is, automobiles including auto busses too often are fair weather machines. In bad weather the public still needs rail transportation.

Since the bus can operate where rail lines cannot they may be used as feeders or adjuncts of railways. The electric and steam lines have finally awakened to this fact and are becoming themselves owners and operators of bus lines. Furthermore, in regions of light traffic the railways are substituting various kinds of bus-like cars, self-propelled, in place of steam trains or electric cars. There is often a marked economy in overhead charges when this change is made, ranging from three-fourths to nine-tenths per mile. In short, we have public need for every kind of transportation we can get and the bus is but one illustration of the fact that no one method of travel can perform every kind of service. Each variety has its own special contribution to make to public convenience.

Busses are manufactured by the makers of passenger automobiles and by truck companies. The Cadillac, Reo, and Studebaker companies all manufacture busses; likewise, the Mack Truck, International, and Republic Truck companies. In 1926 there were 28 different corporations engaged in the production of busses.

The Tractor.—If it were ever truthful to call the automobile the "horseless carriage," then with equal veracity we might refer to the tractor as the "mechanical horse." In reality, a tractor does much work of which no horse is capable.

A tractor is a movable power-plant. It may be employed to push or pull loads or to drag many kinds of machinery after itself. On the other hand, it can be blocked in a stationary position and

its power used to saw wood, cut ensilage, pump water or almost any other job imposed upon a stationary engine. Equipped with wheels, a tractor can go wherever a wagon may be operated. When it is fitted with a continuous tread there is almost no kind of ground a tractor cannot traverse. The maneuvers a skilled tractor driver can execute with his machine pass the bounds of belief.

Beyond all other markets the farm is the best customer for tractors. There it may plow, reap, pull stumps, haul rocks, draw wagons filled with anything a farm needs or produces, run a saw-mill, grist mill, or electric lighting plant, fill a reservoir with water, or milk a cow. But the tractor is equally valuable to men engaged in forest enterprises or mining operations. Public highway departments have found it valuable for road-making or repairing, while country clubs have rolled greens and tennis courts and cut grass with tractors. Indeed, the tractor is more marvelous than the automobile, whose child it is.

To perform all these tasks tractors are manufactured in various sizes and designed so that different kinds of auxiliary equipment may be added. That is, the tractor, like the milk-maid, has several changes of clothes, each suited for different functions.

Although tractors are manufactured by thousands—the Fordson tractor is produced at the rate of 100,000 a year—they are still a new type; as late as 1917 only 254 were manufactured. They have not yet passed from their age of infancy. Most of their history is yet to be made.

Automobile Manufacture an Assembly Business.—An automobile is put together with parts, each part a complete unit in itself. It comprises a frame, a power plant, and a means of power transmission, an electrical system, a body, wheels, tires, radiator and, finally, a number of accessories, such as speedometer, wind shield wiper, bumpers, cigar lighter, flower vase, clock, and other refinements. The Cadillac, for example, has more than 250 parts. Making automobiles thus belongs to the class of what are called “assembly industries.” An assembly industry is in sharp contrast to “continuous” industries, such as that of making cotton cloth,

where nothing essential is added to the original raw materials, the finished product comprising the raw materials manipulated into a new form.

One peculiarity of an assembly industry is that a manufacturer may choose for himself whether or not he will make all the parts as well as assemble them, make some parts and purchase others, or buy all the parts and content himself with putting them together. Automobiles have been manufactured by all three methods. Henry Ford probably comes the nearest to manufacturing a complete automobile, but even he buys some parts—tires, for example. The Studebaker Company also manufactures most of the parts of its cars. Most automobile makers fall within the middle group, manufacturing some of the parts, buying others and making the assembly. A few well-known cars are entirely assembled; that is, the manufacturer makes no parts at all but buys standard parts and puts them together. The Moon and Jordan are cars of this kind.

Ford's method gives a manufacturer complete control of his product, and is supposed to insure having on hand sufficient parts at all times. Makers of completely assembled cars, at the other extreme, argue that their method is advantageous because each part is made by a specialist who by producing quantities manufactures at least cost. Most automobile makers prefer the middle ground, buying intricate parts, such as the electrical system or the body, from a specialist, but controlling their own product by manufacturing its major parts themselves. But the majority of these make hardly more than 20% of the total parts that go into their cars.

Effect of Assembly Character of Automobile Manufacture.

—Since the automobile industry is an assembly business it follows that automobiles may be made at least cost if the parts are thoroughly standardized and produced in large quantities. The American automobile industry, more than any other in the world, secured this result partly because of certain incidents in its history and partly because of the magnitude of the domestic market for automobiles. The assembly character, furthermore, placed certain

limits upon the location of automobile factories. The business was best located when it placed the car factory and the parts producers close together in an area logically related to the consuming market.

Standardizing Parts and Materials by Tests.—One way to discover what materials or parts were best and, therefore, candidates for standardization was to subject them to tests. A favorite method of testing automobiles has been by races and contests.

For many years, from 1900 onward, there were innumerable automobile contests of various kinds in America and abroad. Some were speed races, others hill climbing competitions, and still others endurance meets. Among those that were considered important were the Bennett and Vanderbilt Cup Races, the Daytona and Indianapolis Speedway Races, and the Glidden Tours. French cars generally carried off the prizes until 1908, but in that year the "Locomobile" won the Vanderbilt Cup. From that time American cars seldom have failed to be among those present when prizes were distributed. These contests and races were thorough experience laboratories, for faults of design, construction or parts were glaringly apparent. Moreover, the contests served to advertise the participants and thus broaden the demand for cars.

Of late years races and contests have not been so eagerly espoused by automobile manufacturers. Individual makers, however, quite often test their own cars under the official scrutiny of the National Automobile Chamber of Commerce and if a new record is hung up that fact is displayed in large print in all the periodicals. In addition, attached to many automobile plants are proving grounds. There, under rigid control, cars are subjected to every sort of driving experience and their performance minutely analyzed. Few makers market a model that has not been submitted to long gruelling road tests.

Preparatory to the test of the finished car, chemical and physical laboratories connected with the automobile factories subject everything that goes into them to microscopic or analytical scrutiny. In the factories, too, partially finished assemblies are given "block tests"; that is, the parts are set up and run in such a way that their behavior may be measured.

Changes Wrought by Tests: Body Design.—When Haynes, Duryea, Winton and Olds created their first cars they took the common horse-drawn type of buggy and suspended engines underneath or attached them to one of the axles, sometimes in front, sometimes in the rear. The derisive epithet "horseless carriage" fitted the vehicle. From 1892 to 1899 Poole's Index listed magazine articles about automobiles under the heading "carriages."

The simplest of road tests, that of driving, convinced the designers that a suspended engine was misplaced, for repairs, adjustments and ordinary lubrication were made only by lying flat upon the back in mud or dust. Early in the new century steel manufacturers furnished girder-like materials so that automobile frames could be made wider at the rear than in front and the engine fastened to the frame in an accessible position forward of the front seat. This accomplished, the next question to which experience furnished the answer was the location of the radiator, in front or behind the engine.

By this time an international dispute blazed as to the proper name for the new vehicle, for the new form of the car distinguished it as a unique conveyance. "Horseless carriage" had lost its point; some urged "motor carriage," others "auto carriage," and a few "self-propeller" as proper appellations. France officially declared the term "automobile" to be proper, and soon the world adopted that name.

Carriages were high in order to enable drivers to see over the horse and to escape dust. Naturally, the first automobiles were also high above ground, and they needed to be to escape road obstructions. But heavy and swift cars that were high toppled over because their center of gravity was too far from the road. Improved roads permitted lower cars, and there has been a steady progression in both these matters. With perfect roads cars will be step high.

Panel doors appeared before 1910 and these soon led to streamline design. After 1915 the closed car began to gain popularity and from 1920 onward it made rapid strides in favor. For example, in 1919 only 10% of all cars produced were closed models, but in 1926 no less than 72% were coupés, coaches or sedans.

Mechanical Design.—Constant test not only altered radically the body design of automobiles but still more changed mechanical design. This story is too detailed and technical to recount. But we may suggest that gear shift levers were first brought inside the car from the running board and then the three or four levers were combined in one by means of the Hand key. Springs also were studied, the leaf type entirely displacing coils, but with no standard choice between cantilever and others. The clutch went through many variations, with at least three types meeting general favor. Chain, worm and shaft drives were tried, the shaft finally prevailing for passenger cars. Engines were designed ranging from one to twelve cylinders, with four, six and eight finally becoming the most popular; but the position of the cylinders, opposed, in line, or at an angle has not yet reached standardization. The invention of tungsten filaments gave electric lighting to automobiles in place of canned acetylene or kerosene, and this electric system on the car brought about electric self-starters.

In like manner, tires, rims, mufflers, brakes, wheels, steering mechanisms, and indeed every part of the car, both essentials and accessories, have been subjected to invention, rigid testing, adaptation, adoption or discard. The result is that the car of 1928 bears less resemblance in appearance and mechanical details to the automobile of 1900 than the latest locomotive does to Stephenson's "Rocket."

Design of Commercial Automobile.—The typical commercial automobile differs from the passenger "pleasure" car in having a larger, more powerful but slower moving engine and by a body design that puts most of the load weight over the rear wheels. The mechanical details of the truck have been subjected to the same painstaking study and experiment as those in the pleasure car. The body design of the truck, however, has not been changed so radically as that of the passenger car, for trucks of 1900 could still pass through our city streets without causing undue comment. Yet special bodies for particular work have been introduced from time to time, many having no previous counterpart in highway vehicles. Another difference in trucks as against passenger cars is the continued favor shown electric storage

battery cars for city trucking. One company, in 1926, had a single fleet of 1,550 electric trucks. They save space in garages and on the highways, have lower upkeep charges, and waste less than gas cars in the frequent stops of city traffic.

Trucks may be classified according to their load capacity or by the body design intended for special work. As to load capacity, trucks are made in the following sizes :

- | | |
|-----------------------|-----------------------|
| 1. $\frac{3}{4}$ ton | 5. $2\frac{1}{2}$ ton |
| 2. 1 ton | 6. $3\frac{1}{2}$ ton |
| 3. $1\frac{1}{2}$ ton | 7. 5 ton |
| 4. 2 ton | 8. Over 5 ton |

Of these, the 1-ton truck is by far the most popular, accounting for considerably more than half of all trucks produced. The next most popular sizes are those each side of the 1-ton, namely, the $\frac{3}{4}$ -ton and the $1\frac{1}{2}$ -ton.

In body design there are four classes, (1) stationary, (2) dump, (3) demountable, and (4) special. Each of these has its subclasses. The dumping method is capable of at least five variations. Demountable bodies are of two classes, the *telepheric*, in which the whole body rolls off the chassis, or the *skeleton*, in which the load body nests inside the permanent body, the skeleton being removable. Of special bodies there are legion, ranging from the automobile hearse to the automobile fire engine and the travelling refrigerator.

Almost any truck may be employed to pull a trailer, thus doubling or more than doubling the load capacity. Trailers are as various in types as the trucks that pull them.

Standardizing Parts and Designs by "Shows."—At the last bicycle "show" in New York, in the spring of 1900, a few automobiles were shown on the floor. In the fall of that year the first annual "Automobile Show" was held in Madison Square Garden. Since then, the "Show" has been a regular mid-winter event, not only in New York but in many other cities. Preparation to make an effective showing has been a powerful incentive to every car maker to put the best possible car on exhibition, for by bringing all the produced cars together careful comparison of details is possible. The manufacturers have a double gauntlet, the scru-

tiny of other manufacturers and the popular favor of buyers. Moreover, the shows have been useful in promoting sales in the slack season. These sales, translated into factory orders, kept plants busy, reduced peaks in production and thereby lowered costs.

The shows, however, have had one questionable consequence. They have introduced style into automobile manufacture. Line and color have been substituted for mechanical improvement. This may promote sales if a manufacturer hits public fancy, but it increases his overhead costs to produce yearly models. Moreover, it puts a high priced commodity into the hands of buyers who find their property depreciated at an undue rate, not because it is worn but by reason of its obsolete style. To safeguard themselves and their patrons some manufacturers have taken a definite stand against annual models.

Standardization of Parts Through Patents.—Until 1912 automobile manufacture was under the influence of the Selden patent. This, because of events to be told, forced all gas automobile manufacturers to act together in one or the other of two associations. After the Selden patent expired in 1912 the long period of cooperation led to a remarkable feature of American automobile manufacturing, namely, the pooling of patents and the voluntary standardization of the design of parts and specifications of materials.

The Selden Patent.—George B. Selden, a patent lawyer of Rochester, New York, with an inclination towards mechanics, on May 8, 1879, applied to the United States Patent Office for a patent on a self-propelling vehicle operated by a gasoline engine. This was three years later than Otto perfected his engine but six years before Benz applied it practically to vehicle propulsion. Selden's application included the engine, the clutch, differential and reverse mechanism. Indeed, his application covered the gas automobile as completely as the Morse patent did the telegraph and the Bell patent the telephone. Selden's invention was perfected November 15, 1895, and he was granted patent number 549,160. This slip of paper guaranteed to Selden that for seven-

teen years no person could manufacture gasoline cars without a license from him or his assignees.

Selden, in 1900, sold control in his patent to the Columbia and Electric Vehicle Company of New Jersey, soon reorganized as the Electric Vehicle Company. Selden, himself, who began to manufacture cars in 1907 took licenses under the Selden Patent and agreed to pay royalties per car manufactured.

Ford Suits.—Henry Ford and a few other bold spirits defied the patent owners by manufacturing cars without a license from the patentors. Of course, the latter sued Ford and his associates. Two organizations, as a consequence, came into existence—the Association of Licensed Automobile Manufacturers and the American Motor Car Manufacturers Association. In 1909 the United States District Court decided the patent was valid. This decision caused Ford to be deserted by all his associates, but he alone appealed to the United States Circuit Court of Appeals which, in 1911, held that the Selden patent was valid for motor engines of the Brayton type but that Ford had not infringed the patent because his engine was of the Otto type.

Voluntary Cooperative Standardization.—Upon the expiration of the Selden patent, in 1912, the Association of Licensed Automobile Manufacturers became the Society of Automobile Engineers. This group, made up of engineers and designers in automobile plants, decided that it was to the interest of the industry to establish standard specifications for materials and to set standards for parts. Accordingly, a study was made and a list of standards composed. This reduced the number of conflicting, closely related specifications for materials and lessened the number of parts, but left designers free to follow their own ideas in utilizing standard materials and parts. There were some 200 or more materials and parts on the first list and the list has grown with the years. This sweeping reduction of the number of almost exactly similar products to a few standard ones permitted mass production of these standard articles, either in the motor factory or in another separate plant that specialized in that kind of production. Of course, the unit cost and price were lowered. Also,

there was a guarantee that cars could be finished according to schedule for if some small special part, say a radiator cap, was not delivered on time by its maker, another maker of the lacking part could furnish one that would fit. The parts makers, protected by established standards, developed automatic machinery to make the parts.

Pooling of Patents.—But the influence of long cooperation did not stop with standardizing parts. It extended to the pooling of all non-basic patents.

The moving spirit of this system was Charles C. Hanch of the Nordyke and Marmon Company, formerly a manufacturer of flour milling machinery, latterly the maker of the Marmon car. Hanch knew that the flour milling machinery business had been crippled and almost ruined by patent litigation and disputes. He proposed to remove this menace from the automobile industry. By 1915 the industry was convinced of the wisdom of his plan and, accordingly, the National Automobile Chamber of Commerce was created. This body cross-licensed all its members for the use of any patent gained by any one of them. Up to 1928 almost a thousand such patents had been thus cross-licensed. The scheme did not cover patents that changed in a radical manner the mechanisms of an automobile, nor did it cover body design; but all minor improvements made by one member were free to all other members. The agreement covering this matter extended from 1915 to 1925, when it was renewed.

Market Magnitude.—With standard parts assured and patents pooled, mass production was possible, provided a consuming market existed to buy the cars. The location of this market, if it existed, was also important.

On March 24, 1898, Alexander Winton sold to Robert Allison of Port Carbon, Pennsylvania, a gasoline car of American manufacture. This was the first sale of an American automobile in the United States. Later, when automobiles were more generally introduced, it was assumed that they were limited to use in cities where pavements existed and that within cities only the rich would buy them. The statistics for 1901 seemed to substantiate this

belief. In that year there were 14,800 cars registered. Exactly 25% of them were in the four cities of New York, Chicago, Philadelphia and Boston. Electric and steam cars were the aristocrats, while gas cars were cheap (\$650) rattletraps. Therefore, the distribution between the three types in the four cities was significant of the fact that automobiles really were the "toys of the rich." The distribution was as follows:

City	Steam	Electric	Gas	Total
New York.....	800	500	250	1,550
Chicago.....	150	200	100	450
Philadelphia.....	160	50	130	340
Boston.....	220	90	50	360
Total.....	1,330	840	530	3,700

If this condition as to market had continued the automobile industry in the United States would have been of slight moment. But by 1910 the gasoline cars far outranked both steam and electric together and had a much wider distribution. The greatest number of sales that year were made to the Middle Atlantic, Middle West, Mississippi Valley, and Pacific Coast. The complete sales were as follows:

SALES OF AUTOMOBILES, 1910

	Per Cent of Total
Middle Atlantic	25
Middle West.....	16
Mississippi Valley.....	12
Pacific Coast.....	12
New England	10
Northwest.....	10
Southwest	8
South	5
Export	2
Total.....	100

As early as 1910, then, the automobile was the tool of the farmer. He was the one who needed it most for he lived in a country of "magnificent distances." Automobiles reduced his isolation, gave him a wider, more direct contact with markets for his products, and extended the area of his purchases. They also reduced the time and costs of his hauling both to market and the

return load of materials and supplies for his farm. The fervor of farmers for automobiles was highly important to the manufacture of these machines for until 1920 more than half the total population of the United States was rural. That farmers continued to be the best buyers of automobiles is indicated by two sets of figures, one of sales made by the National Automobile Chamber of Commerce in 1925, the other a canvass of 4 million families, conducted in 1926 by the General Federation of Women's Clubs.

Communities	1925 Sales	1926
	Per Cent of Total Authority: Automobile Chamber of Commerce	Per Cent of Families Owning Cars Authority: General Federation of Women's Clubs
Under 1,000 population.....	28.5	60.5
1,000— 2,500.....	11.3	60.4
2,500— 5,000.....	7.0	54.7
5,000— 10,000.....	8.3	58.7
10,000— 25,000.....	8.9	57.4
25,000— 50,000.....	6.5	59.8
50,000—100,000.....	6.0	57.4
100,000 and over	23.5	54.0

It will be noted that more than a fourth of all automobiles sold in 1925 went to the smallest communities, where the Women's Clubs found, in 1926, that about two out of every three families owned automobiles. The next highest figures both for sales and percentage of families possessing cars was in the small rural towns.

Another way of studying the market is to classify the automobile registration for 1926. This study shows the following results:

Registration above 1 Million
in Order of Numbers

1. New York State
2. California
3. Ohio
4. Pennsylvania
5. Illinois
6. Michigan
7. Texas

Registration 500,000 to 1 Million

1. Indiana
2. Iowa
3. Massachusetts
4. Wisconsin
5. Missouri
6. New Jersey
7. Minnesota

That is, the best market was concentrated in the states that border the Great Lakes, together with the adjacent states of Minnesota, Iowa and Missouri. Outside of this compact market were Massachusetts on the Atlantic, California on the Pacific, and Texas on the Gulf of Mexico. The poorest markets, if analyzed, would be found to be in the South and the sparsely inhabited states that lie within and between the Rockies and the Cascades-Sierra Nevada Mountains.

Not only was the best market for automobiles in farm states and within those states in the smallest communities, but the cheapest cars naturally had the greatest number of buyers. R. E. Olds proved in his earliest experience that an enormous demand existed for low priced, light weight motor cars. Henry Ford adopted the Olds principle. Therefore, it is illuminating to compare Ford production with the total production of all motor cars. In 1904 the Ford output was 7% of the United States total; it rose to 60% in 1918, and in 1925 was 46%. The lowest priced car which exemplified more than any other the principle of mass output of standardized parts for a standardized product held the leading position from 1913 to 1925. Its output alone was almost as great as the combined production of all other companies.

In 1926 about 62½% of all cars whose list prices on the touring model was below \$400 were sold in the central states. The next most popular price class was that of cars listed between \$800 and \$2,500. These, too, found their greatest market in the central states; only in the North Atlantic and Pacific Coast States did cars in this class outsell the lowest priced ones and even in these the margin was slight. Cars listed above \$2,500 sold best in the North Atlantic States, but even there their sales were scarcely 5% of the other two.

The domestic market for American automobiles, then, is for a relatively low priced car which finds its greatest outlet in the central states, with farmers the best buyers. That the automobile is the idol of the masses and not the toy of the rich is shown by the fact that the 1926 registrations were about four times the number of persons making income tax returns. The right priced car in our domestic market has no apparent limitation to the volume of

its demand. Once it was thought there was some "saturation point" in demand, but this was before it was definitely proved that one car per family was not the limit of demand. In 1926, 2 million of the 15 million families that possessed cars owned two cars. Now it is deemed that the saturation point may be a car for every adult in the family. There are still about two new buyers of cars who never before owned one for every buyer who is not purchasing for the first time. So the domestic market for motor cars is an unknown quantity, but is already extraordinarily large. Since 80% of the world's automobiles in 1926 were registered in the United States, if our makers ever reach our saturation point of demand there is all the rest of the world still waiting for cars. Whereas we have one car to every six persons, the rest of the world has one car for every 65 persons, a margin sufficient to appeal to the selling instincts of American manufacturers.

Localization of Automobile Manufacture.—The first large-scale automobile factory, that of R. E. Olds when he produced the earliest Oldsmobiles, was located at Detroit. This was probably accidental and due to the fact that Olds' financial backers were Michigan lumber magnates. When Ford, in 1903, put his first factory at Detroit, again casual motives were uppermost. But the expansion of the Ford business alone would have set Detroit on the pinnacle of automobile manufacturing if it had no other plants at all. Since the automobile industry is an assembly one it was bound to grow where it got a good start. The makers of parts found it most advantageous to locate where the market for the parts was greatest. Later, new companies about to manufacture automobiles sought the neighborhood of plants producing parts. Thus, the advance of Michigan as an automobile manufacturing state was natural and normal. Next to Michigan, its adjacent commonwealths, Ohio, Indiana and New York shared with it the prosperity that rose height upon height with the popular demand for motor cars.

Within these states Detroit, the pioneer, became the leading automobile manufacturing city, followed by Cleveland, Buffalo and Indianapolis.

From the manufacturer's point of view this regional concen-

tration was admirable, because the area was close to the greatest producers of steel and coal in the country, and also was a great lumber market. The situation in respect to raw materials hardly could have been improved. After the automobile accessory industry began to coalesce in this locality there was no more admirable location anywhere for an automobile plant.

From the marketing viewpoint the area was ideal for, as we have shown, the largest market was either in these same states or the ones contiguous. Furthermore, the center of population for the whole United States has been for twenty years in the environs of Bloomington, Indiana, an important consideration for a manufacturer whose bulky, heavy product is sold f. o. b. factory. The only maladjustment of national automobile production to markets is in Texas and California. Each of these has a large local demand for motor cars but is a long distance from the points of production. Yet their local consumption is so relatively small and the nearby states demand so few automobiles that the savings that come from mass production would be lost to plants in these states. This loss would probably offset the savings in freight charges. Branch plants of Detroit makers might be the solution of the problem.

Influence of Automobile.—In the thirty years of its life the automobile has influenced for good or evil nearly every aspect of modern existence. It has made cities more intolerable and the country more accessible. Farm life, both socially and economically, has been revolutionized by the automobile. It has promoted public health at the same time that it introduced a new deadly menace to life. Schools and churches have both suffered and gained through this vehicle. The automobile is the most taxed commodity in the nation, a part of the taxes being segregated for the building of new national, state or county highways over which the cars can roll. The financing of the automobile industry from buyer to manufacturer is a large item in the nation's banking business. Some electric railway lines have been killed by rival automobile transportation, while other traction companies, by using automobile feeders, have extended their business. Steam railway lines have had similar experiences. In domestic commerce

the automobile industry is the third largest shipper (after petroleum and steel), while automobile exports rank after cotton and petroleum. Raw materials intended for use in manufacturing automobiles or their accessories bulk large in our national imports.

But the impact of the automobile has been heaviest in manufacturing. The demand for mass production of standardized units, or interchangeable parts, and the idea of continuous progressive assembly have caused many lines of manufacturing to be fundamentally overhauled. Of course, the automobile industry did not invent these principles. Eli Whitney probably was the first American to introduce them when he manufactured guns at the Winchester Arms Works, New Haven. They were later adopted by the makers of clocks, watches, sewing machines and agricultural machinery. But these manufacturing enterprises were of picayune size, compared to the automobile industry. The automobile manufactures themselves are the highest in values in the United States and the industry consumes a large percentage of the total production of other manufactures, ranging from 4% of the zinc production to 63% of the production of upholstery leather. National advertising was born about the same time as the automobile and grew with it. No other commodity has been so extensively and expensively advertised. The success of this publicity induced many other manufacturers to blazon the merits of their product in the public eye. No other manufacturing, not even the iron and steel industry, has had such a widespread stimulating effect. In short, the automobile industry is without an equal in American industrial history.

CHAPTER XI

MEAT: THE ERA OF LOCAL INDUSTRY

Introduction.—The American meat industry has three characteristics that developed early and consistently prevailed. First, there has been a local fresh meat industry, which has distributed in the immediate locality the meat of animals reared nearby, and slaughtered by townsmen butchers. At the same time, there has existed alongside or connected with the local industry another which preserved meat for consumers distant in time or space. Secondly, the men who have engaged in the preservation of meats for remote consumers have placed their slaughter houses as close as practicable to the source of animals. As the latter has shifted westward this branch of the meat industry has also moved. Finally, of the three principal meat animals—hogs, cattle and sheep—the hog has been the main basis for meat packing, while cattle until recent years have been slaughtered near the points of consumption and the meat sold fresh. Sheep and lambs never have been an important source of meat and since 1903 have been declining in supply.

The Farmer Butcher.—Governor Edward Winslow, in 1624, imported into New England from Devon and adjoining English counties the first cattle for settlers along the North Atlantic coast. After ten years of painstaking preservation there were enough cattle and hogs to warrant using the excess for meat. During the first generation each settler was his own butcher. Usually late in the fall, after all the crops were harvested, a few hogs and perhaps a steer were killed for home consumption. After an orgy of fresh meat a supply of dried, salted or smoked pork, ham and beef was stored for the coming season.

This simple system was followed by settlers and migrants everywhere in America from Salem, Massachusetts, to Salem,

Oregon. Not only was this plan geographically universal but also it has been in vogue at all times, including the present; many a farmer is still his own butcher and meat packer.

Local Butchers.—Among the newcomers to America in the 17th century and in the rising generations of American-born were men who specialized in the butcher's trade. These men, as a rule, lived in the villages; but there were some farmers who became notable butchers. The butchers, in part, served as artisans, travelling from farm to farm where they exercised their art to benefit the farmer's larder. This practice to a slight extent may be found today.

In time, however, the butchers usually added the function of meat dealer to that of slaughterer. They bought animals from farmers at the farm, or from farmers who drove their stock to the butcher's slaughtering place. The meat was sold in fresh form within the community. As meat dealers, the local butchers bought meat from farmers who did their own killing and dressing. The butcher sometimes slaughtered the animals he bought at the place of purchase, at other times he was allotted space at some farm where he had his headquarters, but most often he had his own premises at the outskirts of a town near a stream. In the latter case, the butcher generally kept hogs to consume the refuse of his trade which otherwise was buried, burned, dumped into a stream, or left near the slaughterhouse, where it polluted the air and water and provided a local paradise for rats and stray dogs.

This local butcher-meat-dealer system, too, has been spread over the entire country and may be found today flourishing vigorously in the smaller communities.

Preserved Meat Industry.—Both the farmers and the local butchers found it advantageous to preserve meat by drying in the sun, salting, or smoking, thus saving meat from the usual fall season of slaughter, when there was more than the community could eat in the fresh form, until later seasons when fresh meat was scarce and high priced. The development of large markets for preserved meat led to the expansion of this phase of the butcher's trade and soon induced some men to become specialists

in meat packing. Hog products were so much more easily preserved than cattle meat that hog packing was well-nigh the sole representative in the meat preserving industry.

The first market for preserved meats was found in the fleets of New England. The fishermen, the whalers and the commerce carriers all needed commissary supplies. An integral part of the sailor's mess was salted, dried or pickled meat. For that matter, on long voyages so much reliance was placed on salt pork—called "salt horse" by sailors—and so few fresh vegetables and other fresh foods entered the sailor's diet that sailors suffered terribly from the seaman's scourge, scurvy, until the British explorer, Captain Cook, about the time of the American Revolution, pointed out the methods of amelioration. Scurvy sometimes carried off more than half the crew on a long voyage.

When Charles the First and Parliament struggled for supremacy in England (1625-1649), the resulting civil wars left the British possessions in the Caribbean without supplies. These islands had become so thoroughly specialized in sugar production that nearly all their means of living had been shipped to them from the mother country. The absorption of British interest in domestic politics and warfare left the West Indies, as a market, to the alert Americans. They made this market their own while the British were deciding between Cromwell and the Stuarts, so that in 1660, when Charles II regained the throne, the West Indies almost completely were lost to the food producers of the British Isles.

The Americans shipped live animals to the Carib islands for slaughter there and also sent them shiploads of preserved meats and other provisions. New England led in the carrying trade and much of the cargo originated in New England; but all the colonies had a share in furnishing cattle, hogs, and preserved meats to the islands. Indeed, the West Indies for more than one hundred and fifty years were the best market for surplus American livestock, both on the hoof and in the barrel.

Colonial Ranges.—Meanwhile, certain changes were occurring in the livestock and meat industries within America. While all farms continued to raise some animals, special regions appeared

in which livestock production was in considerable surplus over local needs or for farm economy. The first of these was in Rhode Island around Narragansett Bay and on Long Island, but after 1635 and until nearly the end of the 18th century the great open meadows of the Connecticut River Valley favored stock production, which there was conducted on a relatively large-scale. This was true also of the Merrimac Valley after King Philip's War (1675).

The Germans and Quakers of Pennsylvania became the most expert and successful of all colonial farmers and their animals were the best in America. As these colonists filtered into the Great Valley of Pennsylvania and turned southward toward the Shenandoah and Cumberland, they found cattle and hog raising profitable and produced them much in excess of their own needs. About 1770 certain Virginians and Pennsylvanians penetrated the Monongahela Valley, where stockraising on a relatively extensive scale (herds of 500 head) soon became the leading activity. Meanwhile, the Scotch Irish, who drifted eastward from the Shenandoah into the Piedmont, forming a bulwark against the Indians and French for the planters along the Eastern and Atlantic Coast, were primarily ranchers rather than farmers and conducted a cattle business similar to, but smaller than the one later famed on the Great Plains. Some assert that steers were raised as cheaply as hens in the Piedmont. The Connecticut Valley, the Great Valley, the Shenandoah, and the Piedmont were our colonial frontiers, the "Far West" of that time, and they exemplified first in our history a fact that later became characteristic, namely, that the frontier farmer prospers most when engaged in the livestock industry.

Marketing Colonial Livestock.—The relative remoteness of the principal areas of colonial livestock production from the meat consuming and preserving centers called for new methods in marketing animals. Then, as now, the region of animal surplus was distant from the areas of meat consumption. The two had to be linked.

For transportation of cattle and hogs a new functionary appeared, the drover. In the fall of 1654, William Pynchon, the

founder of Springfield, Massachusetts, at the junction of the Connecticut River with the Westfield and Chicopee, drove a herd of cattle from his river-town overland to Boston on the route now followed by the Boston and Albany Railroad. The drover's business became a regular profession, attracting a number of individuals and thriving for about two hundred years, or until the building of railroads made it unprofitable. Drovers conducted their enterprise in all the colonial cattle regions and followed the range business westward after the Revolutionary War. A few temporary drovers may still be encountered in the Rockies or Cascades-Sierras, urging herds or flocks down to rail shipping points.

The drovers went from farm to farm, or ranch to ranch, collecting cattle and hogs until enough were secured to start the journey to market. Drovers bought the animals outright at the producer's place, or took the cattle or hogs at a rate per head for the producer. Once in a while animal raisers combined their herds and hired a drover to prod them to market. Producers themselves might act as their own drovers, but this was wasteful of time and effort, unless the rancher had a large herd. If the drovers purchased the livestock from the farmers and ranchers they generally did so on credit. At the end of the drive they sold on credit too, with the result that meat might be consumed before the money began to trickle back through the productive channels. The buyers of the drover's herds were butchers and meat packers.

Fairs and Market Places.—In order that there might be systematic meeting of sellers and buyers of livestock, the medieval method of fairs was revived. These were succeeded by specified market places where animals could be sold and bought.

Since the fairs were held at infrequent intervals, they proved insufficient as the meat industry expanded. The local legislators then indicated some spot where a cattle market might be held one, two or three days a week. When this limitation cramped the still growing business, every day except Sunday was legally authorized as a market day. At these markets not only did sellers meet buyers but the latter could inspect the animals offered. Still later the livestock were held at convenient places outside the city where buyers might examine them if they wished, but the "marketplace"

for the meeting of buyers and sellers was situated within the business district of the city. An example of this method was the erection of Faneuil Hall in Boston, in 1742. The Maryland Assembly, in 1793, set aside ten acres of land near Baltimore for cattle pens and stalls and declared Thursday in every week to be market day there for all kinds of livestock. William Penn established two livestock market days per week in Philadelphia, Chester and Newcastle, and provided for two annual livestock fairs. Virginia had similar ordinances.

The system of fairs, market places and market days followed the livestock industry westward across the Alleghenies after the Revolution and reappeared in Kentucky, Ohio, Indiana, and Illinois until the railroads brought about centralized cash livestock markets.

Slaughter Places.—Whereas, at first, butchers might slaughter wherever they pleased, the odor and other inconveniences attached to slaughterhouses led to city legislation that controlled both the location of slaughterhouses and, in some measure, their operation. The location, obviously, was nearly always on the outskirts of the cities. The city itself, in some cases (as for example, New York) provided public slaughterhouses. The New York Public Slaughterhouse was erected at what is now the east side of Pearl Street, between Wall and Pine. In other cases, the cities commanded the butchers to centralize their work in one neighborhood.

The most famous of the early slaughter areas, however, grew naturally without explicit command from the city. This was the Brighton district adjoining Boston. It appears that Jonathan Winship started slaughter there during the French and Indian Wars (1756), in order to supply meat to the British-American troops. Other butchers followed Winship and soon the Brighton Market was known all over New England. This noted place became the model for a score of others in the Atlantic States and after the Revolution served as a pattern for markets in the trans-Allegheny territory. The meat business is still an activity at Brighton.

Brighton Market and its types attracted farmers and drovers

who had livestock to sell, as well as meat dealers and packers who purchased meat but did no slaughtering on their own account.

Hogs versus Cattle.—From our earliest settlement down to the present there have been far more swine in America than cattle, even if dairy cattle be included. Hogs reproduced in litters, whereas cattle increased one at a time, and sows reached the reproductive age in about a third of the time for cows. Hogs would eat most anything, including each other, while cattle were particular about their food. This catholicity of diet caused hogs to be used as scavengers on farms, at slaughterhouses and at distilleries. Hog scavengers roamed the streets of Philadelphia and New York as late as 1825. The hog could most valiantly protect itself against snakes, wolves, dogs, and wild animals much greater in size than itself. Cattle, on the contrary, were more easily attacked and killed. This comparison alone favored the hog as a frontier animal. Hogs survived with a minimum of care or attention; indeed, for two hundred years they were allowed to run wild on the frontier clearings, their owners collecting them when needed, sometimes with a gun. Cattle, too, for many generations were turned loose to shift for themselves but they did demand some attention, even if it were so little as providing them with salt. A hog yielded more edible products in proportion to its weight than a beef steer, the difference being about 25%, while the weight of the total useful products from a hog was about 10% more of his live weight than was the case with a steer. This high value of a hog for his weight and bulk made it possible to raise hogs at regions more remote from markets than cattle; that is, he could more easily bear the costs of travel. However, as a result of the vicissitudes of overland journeys, hogs shrank more in weight than cattle, and the resultant meat was inferior in quality. Hogs everywhere in America accompanied settlers, which was far from true in the case of cattle. The frontier hog was of mixed ancestry, large boned, gaunt, independent, unaggressive except when attacked, democratic and thrifty.

From the point of view of the meat industry, the hog was favored over cattle because almost any farmer could function as a hog butcher while he might hesitate to slaughter a bull. More-

over, the hog, besides yielding succulent fresh meat, furnished ham, bacon, and salt pork, all of which could be manufactured by simple processes. These preserved meats were actually better in taste and quality than the fresh pork. Beef, on the contrary, had to be eaten fresh, for until the Revolutionary War, when the British taught us how to make corned beef, the sole means of preserving beef was by sun drying and salting. This meant that hog products could be manufactured near the sources of hogs for a distant market, while cattle had to be delivered alive close to the point of consumption.

Therefore, from the time of Governor Winslow's importation of livestock until the coming of railroads, the opening of the western ranges and the centralizing of the packing industry, the meat industry of America, except the important local slaughtering and fresh meat distribution, was far more concerned with hogs than with cattle. For years cattle on the extreme frontier were more significant as sources of hides than they were as providers of meat.

Hog Packing.—William Pynchon of Springfield apparently was the first man to give all his time in the packing season to the preparation of pork, bacon and hams, destined for consumption by West Indian negro slaves. Numerous successors of Pynchon carried on the business in the Connecticut and Merrimac Valleys; Hartford, Connecticut, became especially noted for the high grade hams its packers turned out. Since hogs were numerous everywhere packing appeared in all the colonies. The label "Connecticut" on ham, pork or bacon was so valuable an asset that it was attached to these products even when they were made in New Jersey and Pennsylvania. The "Cheraw" bacon of Charleston, South Carolina, was as famous in the South and the export market as Hartford ham.

Most of the packers, like Pynchon, were specialists, but in the aggregate a great deal of hog packing was done by individual farmers. In the absence of all knowledge of refrigeration, packing was confined to the cold months, the season usually extending from November to March. Hence, packing was useful to farmers for filling in idle time. The professional packers, too, employed

considerable labor since the entire process was a manual one; therefore, the winter, when other employments were slack, found men of many trades working in the packing sheds. Even at that early date there was considerable subdivision of labor in this business.

Packing was entirely separate from slaughtering. The packers bought their raw materials from butchers, or received them from farmers for whom the packers often worked on commission. Many of the packers were wholesale provision dealers who added packing to their functions in the winter. The "packing house," having no machinery, was either a flimsy shed built for the purpose, or a provision-warehouse in which space was allotted to the packing operations. The business was highly speculative, for neither the raw materials nor the markets were definite and regular; the time element, too, introduced gambling, for materials bought and packed in November might not be sold for six months or a year, in which time the market price of the packed products might differ materially from what prevailed in November. Packers alternated between fortune and bankruptcy.

Westward Movement.—Following the Revolution came the migration across the Alleghenies, first to Kentucky, then to southern Ohio and Indiana and, eventually, into Illinois and Iowa. In the East also there were new frontiers; in New England, settlement progressed in northern New Hampshire and Vermont and in New York the valuable Genesee Valley was opened.

These changes, however, though they altered the location of the livestock and meat industries and added to the volume of both, did not materially affect the organization of the two related industries.

Livestock with their pattering or sucking hoofs paced the line of the frontier as it rolled West and North. In the West the results of the Whiskey Rebellion contributed to the popularity of livestock, for the corn that no longer was condensed into a liquid carried in a bottle was converted into meat borne by the sharp hoofs of a hog. Pragmatically, a fact was discovered which scientists long afterwards proved, namely, that the hog was the most efficient converter of vegetable into animal food. So hogs rooted, romped and squealed over the whole western frontier. Cattle,

though numerous, were not so popular with struggling pioneers for they cost more and returned less. In Vermont, and to a less extent in northern New York and New Hampshire, merino sheep for a time were the favored animals, but these were raised chiefly for their wool. Horses, too, were famed in these eastern frontiers, but naturally these had no relation to the meat industry; the Latin, not the Anglo-Saxon, used horses for human food.

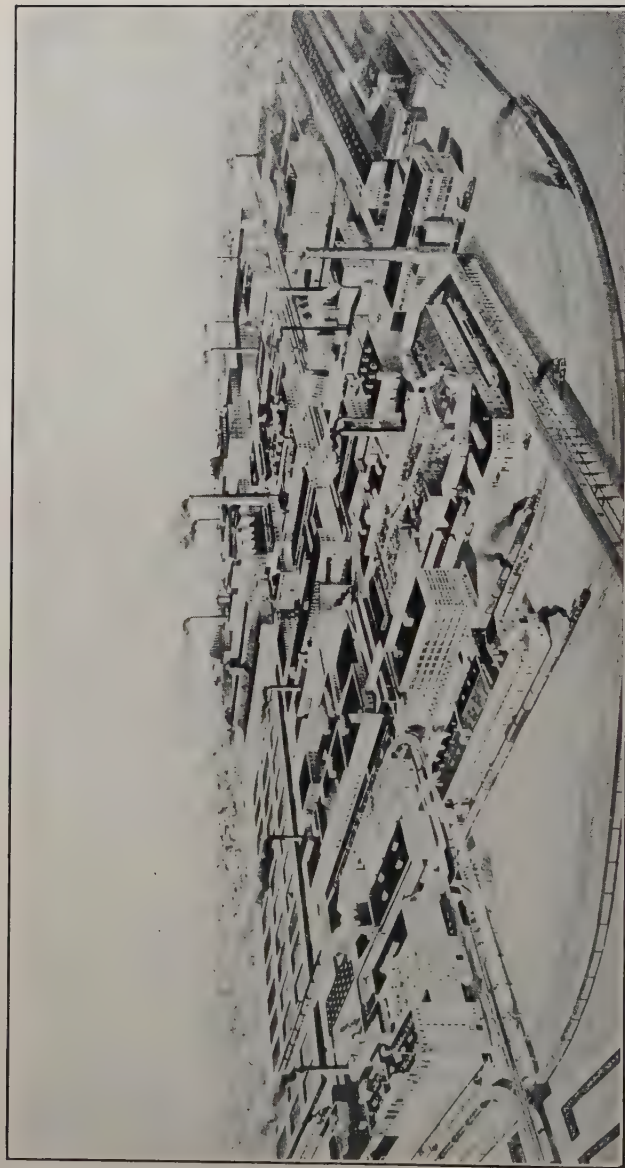
New Markets for Meat.—As livestock production progressed westward the market for meat expanded in the East and South, replacing the time-honored export market in the West Indies. The cities of the East spread fanwise from their original nuclei and many new cities and large towns grew under the stimulus of manufacturing and the domestic commerce to which it gave rise. The farmers, distillers and slaughterers of the East continued to raise hogs but their numbers were much less in proportion to population. As for beef cattle there was both an actual decline in numbers and an offsetting livestock industry in the dairy business. In the South planters devoted their energies to cotton. Before the Revolution hogs had been so numerous in the South that some commentators classed them with vermin or other pests, and hog theft was a lightly punished misdemeanor, not a capital felony; but with the spread of cotton fields hogs were chased off the plantations back into the rough uplands. The planters for themselves and their slaves bought hog products rather than produce them.

Eastern Fresh Meat.—To furnish the East and South with fresh meat, livestock were driven overland to the abattoirs close to the consumers. George Renick, in 1805, drove the first lot of beef animals from the Scioto Valley in Ohio over the Alleghenies to Baltimore, selling the stock at a fat profit. A drover named Drenning, in 1817, walked 200 cattle from Chillicothe, Ohio, to New York City. Following these two successful drives, three hoof-pounded routes were filled yearly from April to August, with eastward wending cattle. These routes were virtually identical with the lines later laid down by the Baltimore and Ohio, the Pennsylvania, and the New York Central railroads.



(From photographs in possession of author.)

PLATE 8. The "Plant" of a Successful Local Butcher. B. E. Lewin,
Hanover, N. H.



(Courtesy Swift & Co.)

PLATE 9. The Chicago Plants of Swift and Company. The world's largest meat-packers.

As the livestock industry passed on into Illinois and Iowa there were two sets of cattle drives, one from these frontiers to Ohio and thence to seaboard. The areas furthest West bred the cattle and passed them on to Ohio corn growers to fatten for market. From Ohio the cattle moved to finish-feeding grounds close to the great eastern cities. Thus arose a distinction in cattle production that still exists, namely, that between "stockers" and "feeders."

The ownership of cattle passed from stockers to feeders at first by means of cattle fairs, originally held quarterly and then monthly. The fairs, as had been the case in the East, were superseded by livestock markets at special places.

Western Hog Packing.—Notwithstanding that hogs outnumbered cattle in the new West very few were driven East for slaughter. Instead, they went to the nearest packing plant. Hogs withstood the hardships of driving less easily than cattle. On, the other hand, pork, bacon and ham had a much readier sale than dried or pickled beef. The situation demanded a sharp cleavage between the practices of the two raw material branches of the livestock industry. It is interesting to note, however, that distance controlled the choice as to the disposition of cattle; those raised close enough to the East to be driven there for slaughter were so handled, while more of the Illinois and Iowa cattle went to local beef packers. In the case of hogs, most of them in any state passed immediately to the closest hog packer.

This meant that hog packing plants were scattered over all the livestock states. But quickly certain packing centers were seen to have advantages over all others; Buffalo, Pittsburgh, Louisville, Cleveland, Chicago, Alton, St. Louis and Cincinnati were the most important of the greater centers, but Cincinnati outstripped all others.

"Porkopolis."—Cincinnati owed its rapid city growth to its admirable location. Its position on the Ohio gave it command of the principal route from the East and the artery to the South. The wide bend in the river at Cincinnati penetrated the heart of the richest agricultural region of the time. The construction of canals

and highways through this admirable farming country brought this area into direct touch with the river highway at Cincinnati. Across from the city the Licking Valley performed the same service in binding that section of Kentucky to the river metropolis. Through Cincinnati poured the migrants and all their supplies, while there flowed back to the city the products which these migrants raised as settlers. There arose at Cincinnati a notable iron rolling industry, shipbuilding and banking. Proud of its earned title "Queen City of the West," Cincinnati reigned for a time as the principal inland city.

Among the new businesses started in this outpost capital of agriculture and migration were the commission merchants. These added pork packing to their regular occupation. The way had been shown by Ohio farmer packers as early as 1811, but it was Elisha Mills who, in 1818, established the first commercial packing house in Cincinnati, followed by the commission merchants who rapidly expanded this branch of their business. By 1832, when 85,000 hogs were slaughtered in Cincinnati, the public discarded the name "Queen City" and dubbed the place "Porkopolis." Until the Civil War Cincinnati was the greatest pork packing center in the world.

The metropolitan character of Cincinnati aided the advance of pork packing to large-scale operation because it provided the requisite capital and labor. Since the mid-western farmers and drovers were paid cash for their hogs by the butchers who, in turn, sold on credit to packers months before returns came from the sold bacon, pork and hams, large financial backing was necessary, which Cincinnati bankers furnished. The packing was seasonal—it was done in the winter—demanding temporarily large forces of labor which could be secured only in a rapidly growing city. The winter demand for labor suited the worker for their other occupations were slack at that time. Not only was labor drafted for work in the packing house but also for drayage, droving and cooperage. The city itself was an admirable outlet for the parts of the hog that were not packed but sold as fresh meat. Thus, in 1828, the heads, spare ribs, neck-pieces, and backbones were thrown away, dumped into the Ohio; as the city ad-

vanced in size much of the meat of this port could be saved and used locally.

Hog Packing at Cincinnati.—The packing industry at Cincinnati comprising 26 houses in 1844 and 41 ten years later—when about a half million hogs were killed there—was separated from slaughtering. The packing houses were located on the wharves or close by, for water transportation; while slaughtering for obvious reasons was conducted outside the settled city area. The meat for packing was carted through the city streets from the slaughter houses to the packing houses.

It was at Cincinnati that hog packing took on its modern aspects. One of these was the minute subdivision of labor aided by mechanical contrivances and gravity. The other was the recovery of wastes, for which purpose manufacturing activities subsidiary to packing appeared. These were subsidiary in the sense that they depended for their location and raw materials upon the packing industry; but in Cincinnati they were independent from the packers in ownership and operation.

The first of these subsidiary by-product industries was that of lard rendering. Besides producing lard from hog fats, the lard itself was passed on to other manufacturers, who, by treating it with alcohol, separated the lard into oil and stearin. Lard oil was used for illuminants and lubricants as a substitute for whale oil. After its appearance in Cincinnati the whale oil market in the West was obliterated. This was an economic advantage in that illuminating oil for local use was furnished from a local supply. In 1849 Cincinnati had 30 lard oil factories. The manufacture of candles from lard products was a by-product of lard rendering.

Another industry subsidiary to large-scale pork packing was the manufacture of soap, in which Cincinnati soon came to leadership in the West. The present large Procter and Gamble soap plant at the suburb of Ivoryton is a modern reminder of Cincinnati's history.

The hoofs and bones of hogs slaughtered at Cincinnati were converted, about 1850, into glue. The bristles were manufactured into brushes. Beef packing itself might be considered another subsidiary industry and it, in turn, furnished horns to the glue

works and hair to the curled hair makers who sold it to mattress manufacturers, the short hair being purchased by builders who put it in plaster for a binder. Cincinnati's cooperage industry depended upon the hog packers and the coopers called upon the iron rolling-mills of the city for bands. "Porkopolis," therefore, was not an ill-chosen name, for much of Cincinnati's economic life turned about the hog packers.

Market for Cincinnati's Pork Products.—The packing houses at Cincinnati supplied fresh meat to local consumers and its bacon, pork, and ham reached all the wider area dominated by the city. But these were not the big markets; the city's principal outlet was in the South, which was reached by way of the Ohio-Mississippi and New Orleans. A smaller but important market was in the East, which derived some of its Cincinnati hog products via Pittsburgh and Philadelphia and some from New Orleans. At the latter port Cincinnati packers touched ocean-going vessels, by means of which their bacon, pork and ham became familiar in Europe and, eventually, around the world. Cincinnati blazed the trail for the American meat export business; some of the packing houses specialized in this field. Foreign capital and in one or two instances foreign pork packers, particularly those of Ireland, had interest in some Cincinnati houses.

Cincinnati's success led to the installation of packing houses on the Porkopolis model in eastern cities. The largest were established at Boston, Providence, New Haven, New York, Philadelphia and Baltimore. These plants competed with Cincinnati for the trade of the Atlantic coast and in foreign markets. Inland at Pittsburgh and Buffalo still other houses—patterned after those of the lower Ohio—arose to supply the regions commanded by these cities. But Cincinnati continued to lead them all until 1861.

Railroad Influences upon Cattle Industry.—Notwithstanding that the first railroad was started as early as 1828, there were no "trunk line" railways connecting the seaboard with the middle West until just before the Civil War. Then the Baltimore and Ohio, the Pennsylvania, the Erie, and New York Central, all

completed their "through" connections. Immediately afterwards railroads advanced to the Mississippi and Missouri rivers. For example, the Ohio and Mississippi Railroad joined Cincinnati and St. Louis, where the Missouri Pacific Railroad continued the rails to Kansas City. Between the Mississippi and Missouri rivers, the Hannibal and St. Joseph Railroad permitted traffic to flow from Kansas City to Chicago. Shortly after the close of the war, the first transcontinental railroads—the Union, and Central Pacific—were opened, giving through communication from Omaha to San Francisco.

The eastern "trunk line" roads, together with the transcontinental lines, opened to rapid exploitation the trans-Mississippi country and promoted the range cattle business. Until the railroad came there was no cattle industry West of the 100th meridian except on the Pacific Coast. The railroads and Texas stock created this business in the "cow country."

Texas Cattle Industry.—Texas had begun to attract attention as a cattle region in the late fifties. Drovers of Texas cattle were sent to feed the gold miners of California and a few drives were made northward to St. Louis and Quincy, Illinois. The cattle men, too, had taken their stock to New Orleans and Mobile for shipment North and East. But the panic of 1857 abruptly halted all these tentative beginnings.

During the Civil War, Texas did not share in the general decline in the numbers of livestock. This state was not the scene of military operations, and the sale of its accumulating beef animals was limited by the union blockade. After the war, therefore, the Texas surplus herds again were driven north to furnish meat for the eastern market and western garrisons or Indian reservations.

These Texas "drives," which were at their height between 1869 and 1879, were full of adventure, romance and color, and have been an inspiration to fictionists, poets and artists. Three routes reached northward: one from a collecting point at New Orleans, where river boats carried cattle northward to Cairo and thence to Chicago by rail, where the live cattle went East over the trunk lines; another was trampled overland by the "long horns" to the Red River, where connection was made with the first route;

while the third, most famous and significant, trailed through adobe, alkali and sand from Texas to Kansas. The Kansas terminal shifted with the railhead. When railroads stopped at Abilene, in 1867, that was where the drives terminated, but as the iron streaked West each new rail's end became a cattle town with no respect for Sunday and the ten commandments and slight awe of law, except that of eye, arm, gun or noose. This shipment from rail end was facilitated by a railroad rate war which, in 1870, made a rate of one dollar a head from Missouri River points to Chicago, and carried the animals free from that city to New York.

After their long powdery, thirsty and hungry journey, the cattle oftentimes arrived at the rail terminal too deteriorated to warrant shipment East. So, about 1871 the practice started of grazing them in Kansas for a season. This led to building up local herds in Kansas, Nebraska and Colorado. The next step was the improvement of breed, for the Texas steers were long-legged, scrawny beasts whose wide reaching horns interfered with economic railway shipment. To call them gigantic goats would hardly be an exaggeration. Their meat was poor, their weight improperly distributed and their horns both a nuisance and a danger to themselves and men. Breeding produced a chunky, broad-backed, short-horned animal, capable of self-foraging.

With the building of new transcontinental railroads these beef cattle usurped the whole range of the buffalo from the Mississippi to the Rockies and then beyond to the Pacific. For decades these animals roamed the plains and mountains, feeding at the expense of Uncle Sam, being rounded up for identification and shipment twice a year. In 1880 only 47% of all cattle were West of the Mississippi, but by 1900 this region claimed 62%; during these twenty years also the total number of cattle had increased 75%. In 1900 of all beef animals 72% of the steers and 84% of the cows were West of the Mississippi. At that time populous New England had little more than 2% of all beef steers and non-dairy cows.

Numberless western steers went to the block without ever tasting corn, but critical judges of meat showed preference for corn-finished beef. The overstocking of the range or failure of water or grass caused cattle ranchers to ship steers before they

were ready for the butcher. Corn Belt farmers found that their farm organization was improved if they did not always breed cattle but bought some at particular seasons for fattening. All these factors were interrelated and led to rangers, shipping stock to the Corn Belt, there to be finished for the butchers. After the Civil War the cattle industry therefore was reorganized in response to railroads.

The Civil War.—The Civil War, therefore, marks the turning point in the American meat industry. The war itself influenced both the livestock and meat industries. Because of the conflict there was a great loss in livestock after 1861, particularly in the South, which opened the way as well as furnished the motive to new centers of production. The food requirements of the armies put a heavy load upon the meat industry, to which Chicago responded most promptly and adequately. During the war the neglected field of beef canning was taken up vigorously and started the nation upon a remarkable burst in canning in which the packing industry had a vital share. The war period, too, saw the feeble beginnings of the shipment of dressed beef from Chicago to eastern markets.

Aside from these direct influences of the war, its period was the time of significant happenings in railroad history that among other effects reshaped the livestock and packing industry. With the war era also was associated the start of Swift, Armour, and Morris, whose personalities and ambitions made packing history. So the Civil War closed one epoch and opened another in the story of the American meat industry.

CHAPTER XII

MEAT: THE ERA OF CENTRALIZED INDUSTRY

Chicago the Railroad Center.—After the Civil War, Chicago became the greatest railway center of the United States and of the world. The trunk line railroads had their terminals there. Intensive railroad building throughout the Corn Belt gave this area the densest railway net in the world and Chicago became the focus of this net. Although the first transcontinentals had their official terminals on the Mississippi or Missouri, virtually by means of connections, leases, joint traffic agreements, and the like, their terminals were at Chicago. The preeminence of Chicago as a railroad center enabled the lake city to wrest the leadership in pork packing from Cincinnati and to establish beef slaughter and packing on a scale and by methods never previously known.

Rise of Chicago in the Meat Industry.—Soon after white men began to trample the wild onions that grew along the southwestern shores of Lake Michigan, farmers drove hogs through the mucky streets of the little village called Chicago. These hogs were slaughtered almost anywhere in the not overly particular shanty-town and furnished meat to the inhabitants, most of whom were interested in the grain trade. As the town grew with the increase in grain shipments regular slaughterhouses were established and by ordinance of the city fathers were located on the south branch of the sluggish Chicago River. Packing houses on a small-scale and devoted both to hog and beef products came next, but their market was confined to the community in and near Chicago.

Livestock at this period were received at the individual yards of the butchers, but in 1848 a relatively large stockyard, named "The Bull's Head Market," was opened under private management. Although there were at that time four sizable packing

houses in Chicago, they were of no more than local significance and were equalled or surpassed by houses in Beardstown, Peoria, Quincy, Alton and Springfield.

Then came the railroads. Immediately hog prices throughout Illinois became uniform, which destroyed the advantages the packers had enjoyed at such places as Quincy or Springfield. Heretofore, farmers near these plants took a low price for hogs in preference to driving them longer distances for a better price. With price differences eliminated, as Chicago had the best railroad connections it received the most livestock. New yards were built to contain these shipments. First, John B. Sherman, in 1856, opened the Myrick Yards, supplanting the old "Bull's Head," which was inconvenient to railroads. Then, the principal railroads built their own stockyards, led by the Michigan Southern (1852) and followed by the Fort Wayne (1859) and Burlington (1864). This scattering of markets was inconvenient and uneconomic, and, accordingly, in 1865 the nine principal railroads entering Chicago having united in securing a charter for the Chicago Union Stockyard and Railway Company, opened on Christmas day a centralized yard tapped by all the railroads and owned mostly by them, but with a few shares bought by private individuals. The Chicago stockyards quickly became the largest in the world and served as a model for others.

With the railroad unloading ever greater numbers of livestock in Chicago the meat packing industry immediately responded. The Civil War came at just the right moment to give an impetus to packing at Chicago. Being the newest, best equipped center, Chicago reacted most readily to the war demand. In 1851 there were 8 packers in the city. Ten years later the city packed 500,000 hogs and passed the record of Cincinnati, the latter never again catching up to Chicago. In 1864 Chicago claimed 58 packers.

Since Chicago's packing business was due to its railroad facilities the old reason for separating slaughter from packing did not exist. (See page 257.) The two functions of slaughter and packing were performed at Chicago by the same set of men, who placed their plants close to the stockyards. These Chicago packing houses jumped into national leadership because the city by reason of its railroad connections was the best fitted to connect

western and Corn Belt livestock production with eastern meat consumption. It was also almost exactly in the center of population. As weighty a reason as any for the position of Chicago in the cattle and meat industry was the caliber of the men who directed its packing business.

The New Leaders.—These men were not village minded nor was their business experience limited to small local affairs. Moreover, two of them came from the East where they had most valuable trade connections. Among these leaders were Philip Danforth Armour (1832-1901), Gustavus Franklin Swift (1832-1903), Nelson Morris (1840-1913), Michael Cudahy (1841-), and Edward A. Cudahy (1860-). The industrial biographies of these men are a large part of the history of the meat industry since the Civil War. If to them are added J. Ogden Armour (1863-1927), Louis F. Swift (1861-), Edward Morris (1893-), Edward A. Cudahy, Jr. (1885-), J. C. Dold (1857-1924), and Thomas E. Wilson (1868-), little else would need be added to the story to bring it up to date.

Chicago Hog Packing.—When the railroads caused the beef cattle industry to move beyond the Mississippi they did not have the same influence on hogs. Cattle and sheep more than hogs demand grazing land. There is not a state in the Union that does not produce hogs. Even arid Nevada, in 1920, had one hog for each three persons living there; tiny Rhode Island had 12,000 in 1920. But after the Corn Belt railroads were built the great national increase in the number of swine is attributable to the states of Iowa, Illinois, Missouri, Indiana, Nebraska, Ohio and Minnesota. The three centers of densest hog population were northwestern Illinois and southeastern Iowa, central Indiana and Ohio, and western Iowa spilling over into eastern Nebraska and northwestern Missouri. The first two of these were tributary to Chicago, while the third looked toward Kansas City. In each of these centers, indeed, in each of the states mentioned, the hogs were not counted by thousands, but by millions. Iowa, for example, in 1920 had nearly 8 million out of a total of 59 million for the United States. Before the Corn Belt railroads were built the

whole United States had only 25 million swine and Iowa one million. The expansion of hog production incident to railroads, therefore, took place in the territory dominated by Chicago.

Naturally, the slaughtering industry of Chicago became most vitally interested in hogs, and the packing industry there for years dealt almost exclusively in hogs. The slaughter, packing and dressed meat trade connected with cattle came after the hog and pork business was thoroughly established. The reasons for this situation are easily presented.

Hogs as a manufacturing raw material were practically standardized as to supply, quality and weight. The widest variation was in the supply which fluctuated in inverse accordance with the price of corn; but, notwithstanding this, the supply was far more uniform than was the case with cattle and sheep. With hogs, weight was the criterion of value rather than quality; this being so, hogs could be sold by description, a valuable marketing attribute of any commodity. A much larger proportion of the hog carcass went into packed meat than has ever been the case with beef. For example, from 40% to 66 $\frac{2}{3}$ % of the total number of hog carcasses were packed, whereas the packing of beef seldom has exceeded 10% of the beef supply. Since packed products kept longer and had a steadier market than fresh meat, hog packing was much less speculative than beef. Hogs were easier to handle alive in the stockyard pens and afterwards in the processes of subdivision. In every way, therefore, hog packing was the more attractive manufacturing branch of meat industry.

Chicago Beef Packing.—Beef packing began at Chicago about the time of the Civil War. Being confined to dried, salted, smoked, and corned beef, it was the smallest, most casual part of the beef industry. In 1874 Chicago concerns began to put compressed cooked beef into tin cans, the first to do so being (William J.) Wilson Packing Company (not the same as the present Wilson Company), followed by Libby, McNeill and Libby. As this form of beef proved exceedingly popular, the business of producing it expanded more rapidly than any packed meat enterprise had ever experienced. It took the place of salt beef on ships and entered homes where nothing but fresh beef previously had been con-

sumed. Beef extract, various meat soups, tongue and other canned beef products were added to compressed beef. Yet while the aggregate of such products was very large, comparatively few packing houses engaged in it, and the total amount of meat so preserved was small compared to the enormous size of the fresh beef trade.

About 4% of beef yearly went into cans. Another 3% was cured and 3% frozen. The latter went into sausage, for Americans refuse to buy frozen meat. The kind frozen, therefore, was the low quality taken from dried dairy stock or poor range stuff. The exception was in the hotel, restaurant and club trade, where the highest grade beef was frequently frozen to "age" it and so improve its taste.

In short, beef packing never has been and is not now comparable to hog packing. Beef has been at all times mostly eaten fresh, not preserved.

The Rise of Other Centers.—The three factors that produced a livestock and slaughtering center in Chicago, namely, the westward movement of the cattle industry, the junction of railroads, and the localization of hog raising in the Corn Belt, acted to create similar, although smaller, livestock markets and slaughtering in other places. Within the Corn Belt itself rivals of Chicago arose, while in or near the large eastern cities the old livestock markets expanded with increasing population, and slaughtering and packing on the Chicago pattern emerged. When the country had become settled from coast to coast, cattle and hogs were produced in greater or less numbers in every state, and consequently, every state had livestock markets and slaughtering. Only 29 of these centers, however, received more than 100,000 head of livestock.

These 29 principal markets were distributed either in accord with livestock production or consuming population. Thus there were 15 of them in the Central States, 7 along the Atlantic seaboard, 5 in the South, one in the Rockies, and one on the Pacific. Although every livestock market carried on some slaughtering, many specialized in the receipt of stock and the forwarding of it to other markets or to feeders. In this class there were 14 centers :

5 in the Central States, 3 in the South, 3 in the East, and one each in the Rockies and on the Pacific. At the other extreme were what might be called terminal cattle markets where from 80% to 99% of the stock received were slaughtered. There were 7 cities within this group, of which 3 each were in the Central and Eastern States and one in the South. Between the extremes were 8 markets where about half the receipts of livestock were forwarded and half of them were slaughtered: 6 in the Central States and one each in the East and South.

If the leading centers were classified in accordance with the number of head slaughtered, that is, as meat manufacturing centers, the results would be: Chicago (2,000,000), Kansas City (1,000,000), Jersey City (800,000), Omaha (700,000), Fort Worth (500,000), and St. Paul* (500,000). The next most important manufacturing points in order were St. Louis, Milwaukee, St. Joseph, Cincinnati, New York, Sioux City* and Indianapolis.* (The cities marked * specialized in hogs.) In order of time St. Louis came first (1870), followed by Kansas City (1880), Omaha (1885), St. Joseph (1897), and Fort Worth (1900).

This set of exhibits would make it appear that the meat industry was decentralized. Geographically, it was. But the four largest packers of Chicago, Swift, Armour-Morris, Wilson, and Cudahy, were the leading buyers and manufacturers at the principal places other than Chicago. Moreover, these four were large stockholders in the stockyards, switching stockyard railways, and stockyard banks, besides controlling the refrigerator car services. Practically, therefore, the meat industry has had one center, Chicago, the leading packers there possessing branch stockyards, slaughtering and packing facilities at places strategically located in reference either to sources of livestock or to consuming markets.

The Chicago Fresh Beef Trade.—During all the early years when hog slaughter was becoming centralized and pork packing an industrial art, the beef trade clung to antiquated methods. The marketing of livestock, after railroads had developed, followed modern large-scale centralizing practices, but slaughter and meat distribution were still old fashioned. There were local enterprises everywhere as big only as the demands of the communities they

served. New York City, in 1865, had more than 200 slaughterhouses and Fifth Avenue witnessed as many parades of steers as now it does of notables.

Large-scale centralized slaughter and national distribution of fresh meat from the slaughter points were brought about by refrigeration, refrigerator cars and branch houses.

Until 1857, even hog slaughter was a winter job, but beginning then a few enterprising butchers carried slaughter through the summer by placing crates of ice and salt about the slaughterhouse. By 1870, all-year hog slaughter was usual wherever ice was cheap. At that time about half the space of the packing plant was devoted to ice houses.

Refrigeration.—Knowledge of the processes for mechanical refrigeration accumulated slowly from its inception in 1550 to its practical culmination about 1870. This creeping advance in artificial production of cold, of course took place outside the meat industry. The first applications of the art of refrigeration also were not connected with meat but with beer and the storage of provisions. It was the success in the latter field that attracted attention of packers. About 1870 mechanical refrigeration was brought into slaughterhouses and packing plants, marvelous economies being effected. It is impossible to overemphasize the revolution in slaughter and packing produced by mechanical refrigeration. The next step was to apply refrigeration to transportation.

The packers were ready for refrigerated transportation for they had already attempted to ship fresh meat from Chicago to eastern cities, first in the winter season alone, and then at other times by means of specially ventilated cars. But their success was meager. Coincident with the mechanical refrigeration in slaughter and packing houses, experiments were made with freight cars iced in various ways; but knowing nothing of air circulation, these efforts failed. G. H. Hammond, a Detroit packer, and Gustavus Franklin Swift of Chicago did the most to further refrigerated transportation, and due largely to Swift's persistence and aid, at last one of Swift's technical experts, a Boston engineer named Chase, discovered the principle of air circulation as applied to refrigeration and designed a practicable refrigerator car. Swift

adopted it at once and soon afterwards Nelson Morris, Schwarzheld and Sulzberger (the forerunners of the present Wilson Packing Company), Armour and others followed suit. Beginning about 1880, cattle regularly were slaughtered at Chicago and the fresh beef shipped East. A quarter of a million cattle were slaughtered at Chicago in 1875, a half million in 1880, and over a million in 1885.

Opposition to Chicago Fresh Beef.—Furor followed. The new system trod on the vested interest of the local butchers and the railroads which shipped live cattle. Every community had its own cattle butchers who thought that their livelihood was doomed if cattle slaughter was to be centralized at Chicago along with hog butchering. Since these men usually were distributors of fresh meat as well as killers of cattle their opposition to Chicago beef was more than vocal. They refused to handle Chicago beef, and by every artifice at their command proceeded to inform the public that "western" beef was of inferior quality and generally unfit for human consumption. The result was a series of state enactments against western beef. Virginia, in 1889, required that all fresh meat be slaughtered within 100 miles of the place of consumption. Minnesota ordered that all fresh meat be from animals inspected within 24 hours of the sale of meat. Indiana and Colorado had laws of similar intent, while the city of Topeka passed an ordinance directly aimed at Kansas City beef.

The railroads knew that the edible portions of a beef animal weighed from 55% to 70% of the weight of the brute on the hoof. Since the railroads were paid for tonnages shipped they saw that they were sure to lose by shipping meat instead of live beasts. The roads that dealt largely in cattle freighting refused flatly to carry fresh meat for the Chicago packers. The railroads also had large investments in stockyards which seemed to be menaced by the fresh meat traffic.

Local Butcher Opposition Overcome.—Swift circumvented the butcher opposition by taking into partnership the leading butchers in each important consuming center; these men, as a result, had a personal financial interest in distributing Chicago

dressed meat. He was able to use this strategy with telling effect in New England, because he himself had come from Cape Cod where he had been a local butcher. Moreover, his numerous relatives—his son was a prominent member of the Society of the Descendants of the Mayflower—were in many cases in the meat business. Outside of his family Swift had many New England connections, because he not only was a “local boy” but for years had been a cattle dealer as well as a hog packer at Chicago, sending live cattle East for butchery.

Armour and Morris, who trailed Swift in the eastern fresh beef business, established branch houses to get their product to local consumers. The Swift partnerships were the best for immediate results, but the branch house proved superior in the long run, so that eventually Swift also adopted that method. Consumers’ palates soon told them that the local butchers were maligning “western” beef, for they not only had been eating it for years—the cattle being slaughtered locally—but when the choice lay between a corn-fed steer and a dried-up dairy cow, the eater’s tongue and teeth were sufficient guides. Nevertheless, for years Chicago beef had to be priced lower than native beef in order to win the eastern housewife’s favor.

Railroad Opposition Overcome.—Agreement with the railroads was reached by applying a rate to dressed meat shipments that would yield to the railroads approximately the same income as from a carload of livestock. But the railroads felt unable to provide the specialized freight cars required for transporting refrigerated meats. The packers, therefore, organized freight companies of their own similar to the railroad’s “fast freight lines.” The packers owned the refrigerator cars and supplied them and their contents to the railroads for haulage. The roads paid the packers a charge for using the cars and assessed rates in turn for the transportation service.

This was a logical economic solution of the car problem. To the railroads the meat traffic was incidental and, at the start, problematical in amount. The refrigerator car was a highly specialized vehicle which was expensive to purchase (\$1,200 apiece at the time), and which needed repairs after almost every trip,

The cars had to be cleaned and iced before loading and iced once or several times en route, which meant providing costly ice stations and crews for a single railroad service. Finally, the cars, with a few limited exceptions, could not or should not be used for any other purpose. The railroads could no more furnish these specialized cars than, at first, they could afford to run their own Pullman type cars.

On the other hand, the packers were reluctant to sink a large amount of capital in cars because their regular business was expanding so rapidly that capital was quickly absorbed. But neither could they afford the slightest delay in clearing their plants of fresh meat which could not be stored, because of the heavy expense involved even if deterioration could be prevented. To depend upon railroads to furnish adequate daily numbers of specialized cars was a will-o'-the-wisp trust. So the packers who entered the fresh meat business were practically forced to furnish their own cars, icing stations, inspectors, car forwarders, and the like. They went into the meat distribution service and hired the railroads to do the hauling.

Once entered upon transportation, the packers soon found that they could cut overhead and add profit by acting as forwarders of other perishable products, such as berries, fruits and vegetables. These required still different specialized cars, but the rest of the service could function as easily for fruit cars as for meats. The national distribution of fruits, berries and green vegetables, therefore, is to be attributed to refrigerator cars serviced by a business built to handle meat. Until this service was available the growing of these perishables was limited to the consuming capacity of the immediate locality, and the consumption was confined to the crop season of that neighborhood. The refrigerator car practically abolished seasons, and expanded markets to national dimensions. Similarly, the packers' refrigerator car service was extended to the dairy, poultry and egg business.

"Peddler Cars" or "Car Routes."—With branch house outlets and ownership of refrigerator cars the dressed meat trade out of Chicago thrived. To pick up the odds and ends of the retail trade the packers at first operated "peddler cars" attached to

local freight trains, and salesmen with the car actually peddled the meat to small town dealers while the train made its scheduled stop. Later the "peddler car" was used for handling together less than carload orders from a string of towns along one railway line. Although popularly called "peddler cars," the packers themselves use the term, "car routes." This is a tactful way of avoiding the implication of packer competition with local butchers. These "car routes" were most popular in the middle and far West and the routes mounted by the hundreds and thousands. In time, both the branch houses and the car routes were still further supplemented by automobile trucks owned and operated by the packers.

As a result of these marketing methods the slaughter of cattle became almost as highly centralized as the hog butchering. But, whereas hog products were mostly packed, the cattle slaughtering centers shipped fresh meat. In 1870 the receipts of live cattle in the East were $3\frac{1}{2}$ times those slaughtered in the West, but by 1903 the receipts were less than one-fifth of the western kill. Up to 1890 the receipts of live cattle at the big eastern cities were less only in relation to population, but after 1890 the receipts suffered an absolute decline. The western slaughter of beef in 1903 was 25 times that of 1870.

Markets for Packer's Meat.—The regions of cattle deficit naturally were the best markets for the "packer's" meat. Of these, New England had the smallest number of cattle in proportion to population. The Middle Atlantic States came next. The South Atlantic States, although short of cattle per capita, were pork-consuming rather than beef-eating areas. Of the states East of the Mississippi, dependence upon the "packers" for beef was least in the Corn Belt States closest to the slaughter centers. Of the total consumption of fresh beef, the packers, by 1900, supplied 75 to 80% in New England, 50 to 55% to the Middle Atlantic States, and 20 to 25% to the South Atlantic and Corn Belt States.

Within the broader geographic areas the best markets for "packer's" fresh beef were the cities. There was a direct relationship between the size of the community and its dependence upon western beef, the larger places being the chief vassals. Towns of

less than 2,500 population were almost entirely supplied by local butchers.

In none of the regions or cities were the national packers without local competition. In all localities there were slaughterers operating on a relatively large scale, and in the smaller places the local butcher was the lord. In this competition the national distributors of fresh meat were at a disadvantage to the extent of the freight rates if the local slaughterers confined themselves to local cattle. This disadvantage was offset, however, by the income the national packers derived from by-products, for the local houses, however large, could not enter the by-product business so extensively as the centralized plants. The disadvantage the national packers suffered in the large overhead expense due to the maintenance of branch plants was countered by adding various side lines (fruits, berries, groceries) to the business of branches. The local "packers," although they had no expensive subordinate distributing agencies, marketed one line only, meat, which had to bear all the expenses of distribution. If the local slaughterers found that near-by livestock was insufficient, so that they were forced to buy at centralized markets, the national packers possessed a clear advantage, for the local plant paid the railroads for about 45% of an animal which was thrown away or only partially utilized, while the national packers shipped meat alone, and the 45% of what would have been waste was made into profitable side lines.

The small-scale butcher in little communities had little to fear either from the national packers or the city local slaughterers. The butcher purchased his animals from his farmer neighbors, walked the stock the few steps or carried it in auto trucks the few miles to the slaughterhouse, which was a small, inexpensive outfit, and sold the meat himself to the ultimate consumers. Sometimes the farmers themselves brought their own stock to the butcher's premises. The butcher had no federal inspectors on his trail and no costly staff to maintain. Although he threw away nearly half the animal, he could afford to do so, for his expenses were much less than half per animal what his competitors paid. The local selling price, on the contrary, was not established by local costs, demand or supply, but conformed to the price set in

the nearest large city. The butcher, too, if the city market favored it, could buy there the meat he resold and wait until conditions warranted before purchasing local farm animals for slaughter.

By-Products.—When both the hogs and cattle were commonly slaughtered at the same centralized market the packers turned their attention to the salvage of waste. The vastness of the accumulation at centralized slaughter forced this action. The Cincinnati houses before the Civil War had accomplished much in the recovery of valuable products from the slaughter of hogs, but this had been done more by separate manufacturers than by the packers themselves. A like condition had grown up at Chicago. After the problems connected with the distribution of fresh beef were well along toward solution the packers began to acquire these allied industries. For example, Armour took over the Wahl Brothers Glue Works in 1884 and later manufactured soap and cleansing powders. Awakened by the possibilities in the by-product part of their business, the packers added chemists and laboratories to their staffs. The discoveries of these scientists pass belief; they are too numerous even to list. They changed many of the packing processes, as well as finding new uses for formerly dumped materials. Their work was made possible in many cases by the refrigeration of the slaughter and packing buildings, and in others, their discovered products were natural additions to the meat lines sold through the branch houses.

A modern "packing" plant, therefore, has two main parts and a cluster of subsidiaries, actual packing, except for hogs, being among the least important operations. Close to the stockyards are buildings for the slaughter of livestock. After butchery the processes are all of the nature of analysis or breaking down into parts, the direct opposite of the automobile industry which is a synthesis or building up. In the packing house the breaking down results in two main groups of products, one, meat (sold either fresh or packed); the other wastes. The wastes may be classified as follows:

1. Fats
2. Hides and pelts
3. Wool, hair, bristles

4. Bones, horns and hoofs
5. Intestines
6. Meat scraps, blood
7. Glands, organs

The wastes are the raw materials for the manufacture of by-products. In the process of manufacture of wastes other wastes may be created which in turn become raw materials for further manufacture of by-products. The by-product plants may or may not be close to the slaughter-packing house. Indeed, some of the by-product plants are even yet not owned by the packers. Both the meat and waste products necessitate packages and the manufacture of these is integrated to the other factories. Finally, the economy revealed in the marketing of the by-products through the refrigerator car lines and branch houses induced the handling and manufacture of substitutes for the meat and by-products (poultry, eggs, butter, etc.) and the addition of other lines that bore no direct relation to the meat industry, such as canned apricots and asparagus, witch hazel and lath. In short, the products sold by the packers began with albumen and ended with yellow corn, with 700 commodities between these alphabetical antipodes.

Manufacturing Problems.—Dealing with products of such range and complexity, under even the most favorable conditions would constitute a sufficient manufacturing problem, but the manufacture of meat involves difficulties of a special nature, that render the problem still more intricate.

Consider first the raw material situation. Since the animals are raised on thousands of farms or ranches, and the same animal may have three or four farm homes before arriving at the slaughterhouse, it is impossible for the packers to own or control the raw material. The livestock of each producing region differs in many respects from all others, yet within each region and even within each herd or flock there are further individualities. All of these variables are made still more inconstant by each season and no two years furnish identically finished animals, for weather and crop conditions produce differences. Finally, the suitability of animals for meat uses varies with sex and age. The packers' raw material, therefore, has no standard quality.

As for quantity offered for sale, there is some relation to prevailing meat prices, but the number varies more in accord with season, weather, or general business conditions. Cattle, hogs and sheep are sold in cyclical quantities, depending upon birth dates, animal food conditions and weather. Each animal group has its own cycle and all of them have the peak of sale at a season other than the peak of consumption. Besides the annual cycle there is a monthly, weekly and daily rotation in numbers brought to market. On Mondays, for example, between 35% and 45% of all the cattle for a week enter market, while Saturday from 7/10 of 1% to 7½% are presented. The morning of any day sees more livestock offered than the afternoon. Although methods have been introduced to regularize offerings of animals, none has had complete success.

Since the centralized livestock markets have scant facilities for holding animals, each day's supply must be disposed either to packers, or to shippers, grazers and feeders. The buying must be speedy, for each day sees thousands of animals put up for sale. Purchases, therefore, cannot be carefully scrutinized, analyzed or deferred, but are based on a swift sweep of the eye; the buyers for the packers who miss their visual guesses by as wide as 3% lose their jobs. Because the stock is bought alive, if the slaughter reveals disease or other defects rendering the meat useless for food, the loss falls on the packers, not the growers. If buyers did not regularly take all animals in the market there would soon be no market.

With an extremely variable raw material both in quality and quantity, the meat manufacturer must slaughter and dress at once. He has no place to keep live animals and, moreover, their food, water and care would eliminate profit. After slaughter the meat must be prepared as quickly as possible or it will spoil. From 500 to 600 hogs are slaughtered per hour at Chicago. Hence, there is marked subdivision of labor; it takes 800 men to butcher and dress a hog at Chicago. The packers were the first to adopt endless chain conveyor dressing, each worker doing his job as the material flowed by him. The reverse of this process—continuous moving assembly—made automobile manufacture famous. Despite the emphasis on haste, packing houses have comparatively

little machinery, the converse being a large use of manual labor. Two factors limit machinery: first, the lack of standardization in, and the size or weight of, the raw material; and secondly, the nicety with which "cuts" must be made, together with the bewildering array of possible "cuts" which may be changed every week. More machinery is used with the preparation of hogs for food than with cattle or sheep, the "key" machine being the hog scraper. Hogs are more standardized and smaller than cattle. With all the speed there can be no compromise with respect to sanitation, or proper manufacturing temperatures. As a whole, manufacturing of any kind is easiest when it is smoothest in flow; crises disrupt orderly procedure. The meat manufacturers find that every day is an emergency.

The meat "packer's" troubles are not over when his product repotes in his cooler. He must sell each day's product immediately or the product will be spoiled. Some hog products and less beef, mutton or lamb may be put in less perishable forms to keep for six or eight months, but there is a time limit to this method of taking the surplus off the consuming market. Speed, then, is essential to manufacturing meat.

The consuming demand for meat is just as variable as the quality and quantity of raw material. First, no two consuming regions demand the same kinds of meats; Boston, for example, wants heavy beefs while the South demands light ones. This same diversity of tastes is recognizable in places as close together as St. Paul and Minneapolis; the former prefers heavy corn fed beef, the latter sides with the Dixie connoisseurs. Within one region, even the bounds of one city, there are marked divergencies in demand. For instance, in New York City the downtown sections buy all classes and kinds of meat, the Riverside Drive apartment dwellers ask for the medium and choice varieties of light weights, while the suburbanites on Long Island and the dusky meat critics of Harlem buy the best varieties of light weight meats. The Jews of New York City will not buy any meat butchered in Chicago, this city being beyond the Kosher time limit of 72 hours—hence the packers' plants in Jersey City. Studies of meat consumption in Boston, conducted by R. J. McFall, showed that the well-to-do eat more beef than pork, while the folks with smallest

incomes reverse this relationship; the Boston Jews eat little flesh of any animal but buy relatively large amounts of poultry; and that the Boston Irish are the greatest consumers of meat, and the Boston Italians the smallest, the ratio between these two being 3 to 1.

The regional differences in demands for cuts and qualities are further fluctuated by seasons and by the business cycle. Contrary to general belief, the most meat is sold in summer and the least in winter—the control factor being employment—but this regular cycle can be upset completely by an unusual hot spell in summer, by feast days, fast days, holiday and building booms. Each week has a cycle in buying, Saturday being the day of heaviest sales. Sunday's feast is warmed over for Monday, Tuesday and sometimes Wednesday. In coast towns, the sudden arrival of the fishing fleet will just about destroy that day's and the next day's meat business, while in the interior the opening of the game season is accompanied by a noticeable decline in meat purchases. The meat manufacturers of Chicago, Kansas City, etc., keep in close daily touch with these shifting consumer-demands, balancing them as well as they can against meat in stock, in transit, and in the purchases made the next day at the stockyards.

While thus gambling on raw material and rushing animals through his plants to take advantage of consumers' demands, the meat manufacturer is hedged around with rules. He must comply in detail with federal laws as to sanitation and inspection of buildings and equipment. Probably no other manufacturing plants are so uniformly standardized, wherever located, as the packing plants. The cuts of meats are defined and governed by the rules of the Board of Trade. Local ordinances sometimes regulate the sale of meat. And a super regulation of all phases of the packer's and stockyard's business is carried on by the United States Secretary of Agriculture.

Profitableness of Meat Manufacture.—With so tangled a business wherein lies the profit? To determine whether or not there is any profit requires an accounting system. Here enters another intricate problem in meat manufacture. Accounting seems to be the most exact of arts for it is mathematical. The

practice of accounting is exact but the determination of a cost accounting system is highly theoretical. How is one to find the cost of a porterhouse steak? It is only one small part of a carcass. The carcass is only part of an animal. The animal is what is purchased, but it is paid for by weight and the weight shrinks in the process of manufacture. That is, the sum of weights of the meat cuts plus the sum of the weights of the by-product materials is less than the live weight. In short, the meat manufacturing industry is an ideal illustration of the problem of "joint costs." There are practical solutions of this problem but none claims definite accuracy.

Taking the figures of the packers derived from their own solution of the problem of joint costs, the profit is small when calculated as a percentage of the capital invested, as so much per head of stock slaughtered, or a percentage of sales. But the packers turn over their capital six times a year, and the volume of the business is extraordinary. Hence, a small unit profit may be multiplied into a huge total profit. Of course the packers, like other manufacturers, have years when they suffer losses; the year of 1921, for example, was particularly disastrous to them.

"Busting the Meat Trust."—The "Big Businesses" that in the eighties and nineties arose in railroads, steel, meat and others, stirred America first to boastful admiration and then to uneasiness and fear. This culminated in what, at the time, was labelled "Trust Busting." The packers were singled out for repeated attack, probably because in one way or another the meat industry touched the majority of the inhabitants of the country. Livestock producers were disgruntled over the prices they received and accused the packers of manipulating the markets. Commission men were dismayed at the changes brought by refrigerator cars, and levelled charges of unfair unscrupulous usages at the packers who operated such cars. Wholesale grocers and provision dealers saw the packers widening constantly the definition of "by-products" and charged the packers with conspiring with the "Money Trust" to monopolize all the necessities of life. Local slaughterers feared the national packers would drive local men to the wall. Small butchers dreaded a like fate. Consumers knew that meat prices

had risen and accepted as truth that the packers had deliberately gouged the family pocketbook. To all these interested parties were added those who displayed familiar traits of human nature, that of envy of others' success and the assumption that sudden fortunes always are due to dishonesty. Few men actually came face to face with the packers in the conduct of business—neither cattle men nor consumers saw the principals of the industry—and absentee overlords seldom have been popular. The packers remained silent to attacks except when driven to speech on the witness stand, and this was taken as evidence of guilt. Few business men have been so generally and so bitterly, though impersonally hated as the packers.

In 1890 a Senate investigation of the meat industry revealed a startling dominance by six packers in the leading livestock markets. The packers denied collusion to control these markets but they were disbelieved. To set bars to the deeds of "Big Business," including the packers, Congress passed the Sherman Act. In 1902 the Department of Justice looked into the meat industry and found pooling practices which it deemed were counter to the Sherman Act. The courts, listening to the Department's complaint, permitted the continuation of the packers' shipping pool but issued an injunction prohibiting combination in restraint of trade (already illegal under the Sherman Act). The House of Representatives, in March, 1904, instructed the Bureau of Corporations of the Department of Commerce and Labor to investigate and report upon the meat industry to ascertain if artificial manipulations were the cause of the low prices for cattle and high prices for meat. The Commissioner, James Rudolph Garfield, made his report the following year. He found that six packers were the biggest cattle buyers, slaughterers in the leading markets, and shippers of fresh beef. But he asserted there was no evidence of monopoly control in the meat industry and that cattle and meat prices were in accord with supply and demand. He also reported that the profits of the six packers were reasonable. This Garfield Report was so different from what the public expected that it was ill received; indeed, it was itself attacked. About this time Upton Sinclair published the "Jungle," purporting to tell the story of packing from the worker's viewpoint. The public was so stirred

that an investigation followed and, in 1906, the Federal Meat Inspection Act was extended to cover sanitary conditions in the buildings and grounds of slaughterers engaging in interstate trade. In this same year the packers were once more arraigned before the judges on charges of violation of the Sherman Act. The packers claimed immunity from prosecution because of the manner in which the information was obtained on which the case was based. The court agreed and freed the packers, but the public considered the claim for immunity as tantamount to confession of guilt.

Six years later criminal charges were brought against the packers for their alleged purposes in forming the National Packing Company (a holding company) to stifle competition and restrain interstate commerce. The jury held the packers innocent, an unpopular verdict. In February, 1917, President Wilson ordered the Federal Trade Commission to investigate the meat industry. The report issued the following year was a scathing denunciation of the five leading packers; in fact, the commission injured its case by plainly exposing its own bias. In 1919 the packers once more were in the hands of the Department of Justice, which was prepared to submit to a Federal Grand Jury evidence of combination in the meat packing industry in violation of the anti-trust laws. While expressly denying guilt, the packers nevertheless agreed with the Department of Justice in obtaining from the Supreme Court, in 1920, a Consent Decree.

By this decree, Armour and Company, Swift and Company, Wilson and Company, Inc., Morris and Company, and the Cudahy Packing Company and certain subsidiary or affiliated corporations and certain individuals were enjoined from monopolizing or attempting to monopolize public stockyards, stockyard railroads and terminals, market newspapers, public cold storage warehouses, and the retail meat business, and from the manufacture, selling or distribution of enumerated wholesale grocery lines, non-related to the meat industry. In practice this decree failed to divorce the packers from control of stockyards and refrigerator car transportation. Seemingly in violation of the decree, Armour and Company, the second largest packing company in the country,

purchased in 1923 the business and assets of Morris and Company, the third largest concern. In 1924 Armour and Swift (the latter the largest of all packers) sought to have the decree set aside. Meanwhile Congress, in 1921, had passed the Packers and Stockyards Act giving to the Secretary of Agriculture sweeping powers of regulation of the meat industry in the interest of the public. Therefore, when two of the packers sought relief from the decree, the Senate, which had relied on the decree in passing the act of 1921, asked the Federal Trade Commission, in 1925, for further information and recommendation to bring the packers to book. The Commission pointed out the failure of the packers to abide by the decree and the virtual flouting of the decree when Armour took over Morris, and so recommended that the packers be compelled to give up their holdings in stockyards, refrigerator cars and the manufacture and sale of products not related to meat packing.

At the time of the first report by the Federal Trade Commission the proportion of the five packers in the total United States inspected slaughter of all classes of animals was 70.5%, but by the year of the second report the independents had gained on the five (then four) to the extent that the big packers had only 60.6%. The meat industry, like the steel industry, indicated that whether or not the largest corporations intended to effect a monopoly, in fact they were unable to do so.

Government Inspection of Meat.—The government regulation set up by the Federal Meat Inspection Act mentioned above was welcomed by the packers because it aided sales both at home and abroad by promoting public confidence. The federal inspection begins with the live animals in the stockyard pens. At every stage of the slaughtering and packing operations the government inspector stands beside the packing house employe. Immediately after the killing the inspectors examine the glands of the head and throat of the animal, for these glands give the first and best evidence of the animal's condition. Later the viscera are looked over carefully by the inspector, and each part of the animal as it is subdivided is given an equally careful inspection. By means of marks it is possible to identify every animal even after it has been cut into

the smallest parts. The preparation of the various parts and even the packaging of the parts ready for sale are under the eyes of the federal supervisors. Their word is law. They are not permitted to accept any gift whatsoever from the packer and are shifted from plant to plant at frequent intervals.

Foreign Trade in Meat.—Americans began to export meat products in the first century of settlement. Pork products from Cincinnati later invaded Europe and were carried beyond into Asia and Africa. With the rise of Chicago, the amount and variety of packed pork sent abroad increased. Certain Irish pork packers, long famous in the British market, established branches first in Cincinnati and afterwards in other livestock centers. Live cattle followed packed pork abroad, and with the development of refrigerated transport its principles were applied to ocean carriers, so that fresh beef, lamb, mutton and pork were taken to foreign markets.

The packers had exactly the same opposition to overcome in getting a foothold in foreign markets as they had in the domestic, but they succeeded in both. Nationalistic legislation plus tariff provisions by alien nations hindered the expansion of the foreign trade in meat but did not stop it. Economic changes have triumphed, however, where laws failed, for our foreign trade in meat has been declining for a decade or more. It revived enormously during the World War but this was exceptional.

The changes that have reduced our meat export have been the great expansion of our domestic market, the passing of the free range for cattle in the West and the rise of competitive cattle ranches in foreign countries, particularly Argentine, Australia, New Zealand and South Africa. The number of American live animals shipped abroad has been reduced to a trickle, and our export of fresh beef is hardly in excess of our imports of that article. So we are back to the point from which we started; that is to say, our foreign trade in meat is largely in packed pork. Although the actual volume of this has continued to increase, the percentage which our total foreign trade in meat bears to our total annual slaughter has been shrinking. By 1927 our beef exports had almost vanished and our pork exports showed signs of decline.

This is a natural consequence of the advance of our population and the per capita decline in our livestock.

The Decline in Livestock and Meat Consumption.—Two sets of figures set against each other tell an apparently startling story. Between 1900 and 1927 our population rose from 76 million to 118 million, while in that period the number of our cattle, hogs and sheep taken together declined from 192 million to 152 million.

Between 1907 and 1926 our number of cattle per capita dropped from 0.78 head to 0.52, or a decline of 33%. But this includes dairy stock; if beef cattle alone are considered, the shrinkage was from 0.43 to 0.23 head per capita, or 46.6%. For swine, the per capita supply was 0.7 in 1907 and 0.45 in 1926, or 35.7% decrease.

These per capita losses in food animals are seemingly reflected in the annual meat consumption per capita. In 1900 this was 180 pounds, but by 1922 had declined to 150 pounds, rising again to 160 pounds by 1926. Argentine and New Zealand are consuming about 300 pounds per capita and Australia over 200 pounds. Canada's consumption is about the same as ours, while Great Britain, noted for its hearty appreciation of roast beef and mutton, consumed only 127 pounds of meat per capita. This indicates that countries in the early stages of settlement and development are extensive consumers of meat, while the greater the age, the less the amount of meat eaten. If this is true, our declining consumption is normal and will continue.

The cause for the shrinkage in American herds and flocks is the fact that rent has become a prime factor in the cost of stock raising. Steers and sheep have been cheap-land animals. There is more than a kernel of truth in the assertion that human migrations from central Asia westward, and from Europe westward across the United States, were caused by man's search for cheap land upon which to raise his food animals. But our free range passed in 1885. Stock growers then bought a home ranch with water supplies and rented grazing lands. But the crowding homesteaders finally compelled stockmen to purchase and fence land for cattle corrals. This type of animal agriculture came into com-

petition with other profitable agricultural uses of the land. A steer may roam over the 20 acres necessary to feed it if the acres are free or worth less than \$25, but when the acres may be used for grain, fruit or vegetables whose income from the 20 acres may be from \$400 to \$20,000, the price received for a steer—say, \$60 to \$100—will not warrant putting him on land valued in accordance with the income possible to receive from it. Farming thus has tended to dispossess livestock. Of course, not all of our cattle ranges are suitable for farming—much of this land is first cousin to desert—but farming continually invades their edges, thus compressing the area of the circle devoted to livestock. This can have but one effect, to raise the price of livestock by decreasing the supply, provided meat consumption is maintained. Non-range land close to populous centers if devoted to livestock must turn to dairy rather than beef herds, for the ruminative milk cow can earn her board and lodging even on high-priced land and when unproductive as a milker still has value as a meat animal. Unfortunately, the meat from dairy stock is not high quality. Already, between a quarter and a third of all cattle presented for sale at all markets are classified as dairy stock and at St. Paul more than half the cattle offered come from the dairies of Wisconsin and Minnesota.

There are, it is true, certain counter-balancing facts. First, the decline in *numbers* of livestock is not an entirely proper criterion. Breeding encouraged by expensive land and higher-priced stock has produced an animal with more of its weight distributed in parts from which the most salable meat comes, and less in horns, legs, and necks. A herd of 100 Texas longhorns *out-numbers* a herd of 50 Herefords, but the latter will dress out more meat than the former. Moreover, the longhorns or eastern oxen were kept for eight years before slaughter, whereas the modern pure-bred beef animals are ready for slaughter in half that time. That is, the herds of the past had to be larger because the animals had to be carried twice as long a period.

The range cows of former years, although numerous, were not prolific in offspring. By breeding and care there has been a gradual improvement in the births of livestock per thousand. For example, between 1907 and 1926 the birth-rate figures for

cattle increased from 253 to 374, for sheep from 332 to 422, and for swine from 845 to 1,212.

With better beef animals, maturing more quickly, and more prolific stock, the actual slaughter of livestock in all three branches has decreased much less per capita than the decline in numbers. We have fewer animals, but we make better use of what we have.

Turning to the decline in meat consumption per capita, it may be said that due to refrigeration there is less spoilage of meat in the racks of the butcher shop, while the family refrigerator of today saves more meat than the galvanized pail hung down the well, which was used for a cooler by our fathers. The improvement in the breeds of animals yields a carcass more of which contains preference cuts and each cut contains more edible proportions than formerly. So it may well be true that the actual amount of meat *eaten* is scarcely less, although the number of pounds sold are fewer than a generation ago.

On the supposition that none of the mitigations of the situation regarding numbers of livestock and consumption of meat per capita are valid, the principal calamity involved in the decline of the meat industry is to the butchers and those few cattle growers whose land is unfit for other uses. Meat eating is a habit, not a necessity.

Importance of the Meat Industry.—The only manufacturing industry which exceeds the wholesale values produced in slaughtering and meat packing is that which furnishes motor vehicles. In 1925 the value of all motor vehicles made was 3.3 billion dollars, and of slaughtering and meat packing 3 billion dollars. No other industry, even that of iron and steel, came within one million dollars of these two leaders. A limitation concerning the meat industry, however, should be recognized; the value of its product is mostly that of the raw materials and not the work done upon them. That is, in the meat industry the manufacturing processes add a value of only about 20% to the cost of the raw materials, whereas in the iron and steel industry 50%, and in the motor vehicle 80% is added by the manufacturing.

Comparison based on the capital invested place slaughtering and meat packing about on a par with automobile manufac-

ture, but each of these carries an investment only about one-eighth of that in iron and steel. If the number of wage earners employed be the criterion of rank, the iron and steel is the only one of these three that is in the front rank, while both the automobile and meat industries are exceeded by a half dozen others.

Another peculiarity of the meat industry is the scale upon which slaughtering and meat selling may be done. Despite the large capital investment in most packing enterprises and one that is compulsory if full use of by-products is attempted, the enterprise may be so small as to comprise one man, one cow, and one tree. Obviously, there is no like possibility in the automobile or iron and steel industries. Many a provincial impecunious butcher is the potential, if not the actual, competitor of Swift and Armour, with their millions of investment, far flung plants, branch houses, and thousands of employes. Meat manufacture is the only leading industry in America that has as a commonplace feature the most primitive, smallest-scale manual methods in active operation along with the newest, largest, most capitalistic, mechanistic procedure.

CHAPTER XIII

NORTHERN COTTON MANUFACTURE—ERA OF WATER POWER

Origin.—The earliest written reference to cotton was in a Hindu hymn dating fifteen centuries before Christ. It appears that even then cotton had been used for a long time in India. Chinese records indicate that Indian cotton was traded in China at a very early period. Herodotus (484-402 B.C.), Nearchus, admiral of Alexander the Great (327 B.C.), and other ancient explorers comment on cotton in India. Knowledge of Indian cotton percolated the western trade routes through Persia, Arabia and Egypt, reaching the latter about 200 B.C. The Moors brought information concerning cotton into southern Spain.

But India's storehouse was not opened to Europe until 1631, when the British East India Company first bought high-grade calico at Calcutta and shipped it to England. Samuel Pepys, writing in his diary in 1664, records a dispute between the British Collector of Customs and an official of the East India Company as to whether calico was linen. Whatever its definition, it was alarmingly popular in Great Britain. The craze for this novel cloth, named from the port of its purchase, so threatened the cherished wool industry of England that Parliament enacted laws in 1666, 1700 and 1720 to protect the wool trade and to demolish the upstart cotton. In 1768 no less than 80 London women were convicted and fined £5 each for wearing chintz gowns. But the wool-weavers themselves forsook their wool for the new cotton and, surreptitiously copying the Indian calico, placed it upon sale in the English market. Although the cloth was not entirely cotton, the warp being linen or wool, this action marked the beginning of English cotton manufacture. Parliament modified the law in 1736 to permit the sale and wear of calico made in Britain, provided the cloth had a linen warp.

In the western world, also, cotton was a native plant, or at least was well known before the first European came to America. Columbus found it in use in the West Indies; Magellan reported that the Brazilians were familiar with cotton; and Cortez looted cotton from the Inca treasures. It was said by the Spanish, in 1536, that cotton was growing wild in Louisiana and Texas.

Colonial Use of Cotton.—When Great Britain restricted the sale and wear of Indian calico in her homeland, she encouraged its introduction in the American colonies, where it came into no direct competition with British wool. Inasmuch as our climate favored light clothing, Indian calico was highly regarded by the grand dames of our colonial seacoast towns.

The cotton plant was introduced from the West Indies, Brazil, India and Egypt, attaining its first importance on the peninsula of Delaware and Maryland. It did not there attain the status of a commercial field plant but it was a favorite garden shrub. From the peninsula, cotton planting crossed the Chesapeake into eastern Maryland and Virginia and thence southward. Toward the North it appeared in gardens as far as Philadelphia. As an ornamental bush it was sufficiently common to furnish small amounts of lint for household manufacture in the Chesapeake colonies, although rarely was a piece of cloth wholly cotton. Further South the plant was regularly cultivated for household manufacture. In the North, too, raw cotton was imported from the West Indies for spinning into yarns that were mixed with other textile fibers in making household fabrics.

The colonies, therefore, were quite accustomed to cotton cloth, either from the relatively large amounts imported from India, or from the mixed goods containing cotton which the colonists manufactured in their homes.

Inventions.—In the generation before the American Revolution a series of remarkable inventions caused England and Scotland to make giant strides in cotton manufacture. Between 1725 and 1760 spinners were turning out more yarn than the weavers could put into cloth, because both were hand operations and spinning was the simpler of the two; but in 1733 John Kay of

Colchester invented a flying shuttle which greatly hastened weaving. At first, this improvement was confined to looms producing wool cloth because it effected greater savings on the wider wool looms, but after 1760, when John Kay's son, Robert, invented the drop box, by which several varieties of weft or filling could be worked into the same fabric and thus figured goods be woven instead of printed, both Kay inventions were applied to cotton looms. Weaving, thereupon, was accelerated over spinning. Before long, however, the deficit was made good. The spinning jenny, patented June 22, 1770, by Hargreave, gave larger amounts of yarn; the water frame, patented July 3, 1769, by Arkwright, yielded strong warp yarn; the mule, perfected in 1779 by Crompton, produced fine yarn. These inventions put the spinners so far superior to weavers that the latter again were lagging far behind in the race for production until the need for a better loom was met by Cartwright with his power loom, patented April 4, 1785. The factory was brought into existence when machines became too ponderous for man-power or horse-power to turn, and so were harnessed to water wheels and steam engines. Watt's steam engine was applied to cotton-mill work in 1784 at Papplewick.

All of these improvements in manufacture put pressure upon the raw material because the old hand method of separating seed from lint was utterly inadequate to supply the voracious spinning and weaving machines of England. To be sure, in India for ages there had been a roller gin called a "churka" and at least four Americans in southern colonies between 1772 and 1790 had made improvements on roller gins. But these were all small machines and were best fitted for cotton with smooth seeds, whereas American cotton, except the Sea Island variety, all had fuzzy seeds. Whitney's cotton-gin of 1793, improved in 1796 by Hogden Holmes' use of circular saws in place of Whitney's hooks, filled the breach. It cleaned cotton rapidly in large amounts. The British at first refused to accept American cotton that was ginned instead of hand cleaned, claiming that the machine injured the fiber, but this assumption was soon proven false by experience. The model of Whitney's original gin is now in the possession of his descendants at New Haven, Connecticut.

In fifty years, then, from 1740 to 1793, the cotton industry, from raw material to finished cloth, was put upon a mechanical basis, overturning the established household hand-work and substituting mills equipped with machines. When George the Third ascended the throne in 1760, the British manufactured cotton goods only to the value of £200,000, but when his ministers signed the Peace of Paris in 1783, British cotton mills were producing goods valued at £2,000,000. At that time, there were 20 Arkwright water-frame factories in England and Scotland. Two years later Arkwright, through a lawsuit, lost exclusive monopoly, so that in the succeeding five years the number of British cotton factories jumped to 150.

Abortive Cotton Manufacture in America.—During the Revolution vague and contradictory reports concerning the British marvels in cotton manufacture trickled into America but after 1783 the rumors were confirmed. We wanted a share in the new industry. Our interest was all the keener because of a feeling that, having cut our political fetters, we ought also to establish our economic freedom. But England refused to sell us any of her new cotton machines and by Parliamentary decree in 1774 prohibited the exportation of parts or plans, and forbade the emigration of skilled artisans. She had a good thing and felt justified in attempting to keep it. At Bridgewater and Beverly, Massachusetts; Providence, Rhode Island; Stateburg, South Carolina; and Philadelphia, Pennsylvania, Americans tried to equal the British inventions, but the results were crude and impracticable, although the Americans were aided by Scotch immigrants claiming familiarity with the Arkwright methods.

Samuel Slater.—The publicity attached to these attempts, however, attracted the attention of a young Englishman named Samuel Slater, a man who had been especially trained in the new systems of cotton manufacture. In response to an advertisement of a prize offered in Philadelphia for information concerning English cotton machinery, Slater left England secretly and went to Philadelphia, hoping there to inaugurate cotton manufacture in America.

With characteristic caution regarding untried enterprises, Philadelphia turned a cold eye upon Slater's demonstrations, thereby losing the opportunity to head the American cotton industry. Slater moved to New York and was engaged in promoting cotton manufacture there when a chance contact with a New England ship captain informed Slater of the interest being manifested in cotton manufacture in Massachusetts and Rhode Island. The captain told Slater that Moses Brown, a Quaker merchant of Providence, was particularly anxious to learn the secrets of British cotton machinery. After an interchange of letters, Slater went to Pawtucket, Rhode Island, and there, with Brown's financial backing, equipped a mill with a full set of Arkwright machinery constructed from memory and set up in a building formerly used as a fulling mill. The machinery was put in motion on December 20, 1790. This was the first *successful* cotton factory in America. It had 72 spindles. The fulling mill proving inadequate, Slater and his associates built a new mill in 1793, 40 feet long, 26 feet wide, two stories high, with an attic overhead.

Slater's Influence.—Just over the state line east of Providence at Rehoboth, Massachusetts, Slater, in 1798, built and equipped another cotton mill. The men trained in these two Slater mills and Slater himself ringed Providence with cotton factories so that, by 1809 in the vicinity of that city, there were 17 enterprises, totalling 14,296 spindles. Three years later, 53 mills, equipped with 48,030 spindles, were to be found in a radius of 30 miles from Slater's first venture. There were more than a score of other cotton factories in Massachusetts.

Outside of this centralized area cotton factories of the Slater type had been started in Connecticut at Norwich, New Haven, and Seymour (then Humphreysville, a part of Derby).

In New Jersey, at the instigation of Alexander Hamilton, a site on the Passaic River had been surveyed and laid out for power canals by Major L'Enfant, the man who planned the federal city of Washington. As the Frenchman's industrial project, however, proved to be too grandiose, the canals were finished by Peter Colt of Connecticut. The power facilities were completed in 1793 and the following year a cotton factory started. This was the

inception of the city of Paterson. Three other factories were erected in New Jersey before the second war with Britain.

According to the reports furnished by Tench Coxe for the 1810 Census, the number and geographic distribution of cotton mills in the United States, all of the Slater type, were as follows:

Massachusetts.....	54	Pennsylvania.....	64
Rhode Island.....	28	Delaware.....	3
Connecticut.....	14	Maryland.....	11
New Hampshire.....	12	Ohio.....	2
New York.....	26	Kentucky.....	15
New Jersey.....	4	Tennessee.....	4

These figures were admittedly inaccurate, but they show a concentration of cotton manufacture in New England and in Pennsylvania (near Philadelphia), together with a spread of the industry southward and into the new West.

Early Trials.—Nevertheless, during the first twenty-four years of its history, our cotton manufacturing industry was quite primitive. The Beverly Factory had depended for power upon a pair of lusty bay horses driven by a boy. Several of the factories built after Slater's Pawtucket project used animal power and some of those in the South were propelled by brawny negro slaves. Though most of the mills were run by water power, their requirements were generally so small that a factory could be erected wherever a brook flowed. Cotton manufacture, a business about which the owners knew very little, was added sometimes as a minor part of another enterprise, or started on trial along with other industrial experiments. In Lancaster, Massachusetts, there were three mills that together employed eight people—four men and four women. There are records of mills whose four walls at different times housed the manufacture of flour, shingles, wool cloth, cotton cloth, augers, bits, gimlets, axes, matches, spokes, shoe lasts, mattresses, pails, shoe nails and candle-wicks. One of the largest cotton establishments at Fall River was originally incorporated as the Fall River Iron Works and still bears that misleading title. The cotton factory set up at New Haven, in 1794, was changed to wool manufacture in 1807, and later to paper making. General Humphrey's mill at Seymour was both a wool and cotton enterprise. Many an early venture in cotton

manufacturing went down under fire, flood or financial failure, leaving only a gaunt, naked waterwheel on a broken raceway to mark the scene of the former activity.

Although not all experiments ended so disastrously, nevertheless even successful mills produced a poor grade of cloth. Number 14 yarn was the standard grade and none higher than number 20 was turned out. The first mills, too, were confined to spinning; weaving remained a household hand process. The yarn from the mills, therefore, supplemented household cloth manufacture. In 1820 two-thirds of the textiles used in the United States were made in homes. In short, cotton manufacture did not spring immediately into prominence but went through a score of years on trial.

None of the earliest American mills were supplied with domestic cotton because the South sold all its cotton to England. Liverpool was a better cotton market than Providence and the freight rates were relatively lower. As a consequence, New England's raw material came over the path of her commerce from the West Indies. The trading boats that plied between Salem, Boston or Providence, on the one hand, and the West Indies, or the east coast of South America, on the other, brought to New England cargoes of raw cotton in exchange for fish, provisions, livestock, meat and lumber.

The War of 1812.—Interference with foreign trade usually operates as a direct stimulus to domestic manufactures. The Embargo and Non-Intercourse Acts of 1807 and 1809, together with the War of 1812, cut off traffic between Europe and the United States in cotton cloth. At that time the grade of cotton cloth that cost 30 cents a yard to manufacture in America could be imported from Britain and sold here for 17 to 20 cents. During the war this cloth rose to 75 cents a yard, a margin wide enough to stimulate American manufacturers to the utmost endeavor. At the same time, outbound raw cotton was held in our ports, and falling back upon the domestic market, lowered the price of raw material. The Census record for the disturbed years shows that exports dropped from 186,000 bales in 1809, to 35,000 bales in 1813. The average price per pound, which had

been 22 cents in 1805, and 16 cents in 1809, touched the low point of 10.5 cents in 1811. When the war closed the price went back to 21 cents.

There are no trustworthy sources of information for the number of new cotton mills started during the War of 1812, but Clive Day, from various origins, has made a tentative calculation as follows :

	1811	1812	1813	1814	1815
Massachusetts.....	5	9	13	12	4
Connecticut.....	1	3	3	6	3
Rhode Island.....	1	4	3	4	2
New York	1	9	2	15	3

Batchelder states that the number of mills within 30 miles of Providence was 53 in 1812, and 140 in 1815. The spindles in these mills had advanced in those years from 48,030 to 130,000. He estimated that Massachusetts alone had 96 mills with 65,264 spindles at the close of the war, which is about double the Coxe figures for 1810. Of the Bay State factories in 1815 only 18 had less than 300 spindles, while the factory of Almy, Brown and Slater had 5,170.

Despite the unreliability of the statistics for the war years, it is evident that the number of mills and productive capacity expanded unprecedentedly. Yet, most of these new enterprises were confined to spinning yarn for household production into cloth. Some of the mills had hand looms and so wove as well as spun, but the weaving was far behind the spinning. The cotton manufacturing industry was hampered by lack of a power loom.

The First Complete American Cotton Factory.—Francis Cabot Lowell, a member of a prominent merchant family of Boston, while traveling abroad for his health in 1811, was impressed with the importance of cotton manufacture, and made a careful survey of mill practices in England and Scotland. On his return to Boston, in 1813, he interested his brother-in-law, Patrick Tracy Jackson, another merchant, and together they organized the Boston Manufacturing Company, erecting a factory at Waltham, Massachusetts. For this factory, Lowell not only redevise and improved the essential spinning machinery but,

what was more important, invented a practicable power loom. The Boston Manufacturing Company was the first in the world to arrange all the processes for the conversion of cotton into cloth by means of power machinery within the walls of one building. The British had followed inherited trade distinctions and had separated the spinning of cotton from weaving. Moreover, despite Cartwright's invention of a power loom in 1785 and sundry improvements made in it by others, weaving by power was unusual in Great Britain in 1814, and the British power looms lacked certain important details added by Lowell.

The Origin of Lowell.—The Boston Manufacturing Company in twelve years outgrew the power resources of the Charles River at Waltham. They secured the services of an English-trained Bostonian, named Kirk Boott, to find a better site for their enterprise, and Boott purchased the property and adjacent farm lands of the Pawtucket Locks and Canals Company, which had unsuccessfully attempted to canalize for commercial navigation the Merrimac River at Pawtucket Falls, Massachusetts.

The Boston merchants reorganized the canal company and improved its hydraulic property. They also organized the Merrimac Manufacturing Company, which obtained from the Boston Manufacturing Company of Waltham the latter's patents on spinning and weaving machinery. The capitalists built a cotton mill, another for the manufacture of textile machinery, and laid out a town, building the houses and other needs. To this village they gave the name of "Lowell," in honor of Francis Cabot Lowell, who had died during the short "dumping era" following the Peace of Ghent when the British tried to regain the American market by selling cotton cloth without regard to cost. The mill wheels began to turn at Lowell in 1823. The project was an immediate success not only as a cotton manufacturing enterprise but as a real estate development and water power promotion.

The Rise of Lowell.—The rapid rise of the city of Lowell was the marvel of the times. It reads today like the romance of some of our western cities. In 1836 the town was made a city and within twenty-five years became the largest place in Massa-

chusetts, except Boston. Land values took a corresponding leap. Kirk Boott, the original purchaser of the site of Lowell, bought 90% of a farm of 110 acres at the rate of \$17 an acre, but his plans became known before he could secure the remainder, and he was forced to pay \$362 an acre for $7\frac{1}{2}\%$ of the original farm and \$2,222 per acre for the remaining $2\frac{1}{2}\%$. Two years after the first mill of the Merrimac Company, the Hamilton Manufacturing Company was established at Lowell and this was followed (1835) by the Boott Mills. Each of these added regularly to its holdings. By 1850 there were 33 mills along the power canals at Lowell and this city then was the principal cotton manufacturing center of the United States.

Other Centers in New England.—Lowell, the most striking example of concentration of cotton manufacturing, was by no means the sole illustration. The men who founded that city found, in 1845, that the mill magnitude had overtaken the power capacity by the means then available for water power utilization. So these capitalists went further down the Merrimac River and selected the site for another town, which they called "Lawrence." This community repeated the history of Lowell—lawless as a mining camp for two years, an incorporated town in 1847, and a city six years later. The financiers who backed Waltham, Lowell and Lawrence went over into Maine, where on the Saco River they erected large mills at the towns of Saco and Biddeford and on the Androscoggin they put factories at Lewiston.

A similar development occurred on the reaches of the Merrimac north of Lowell in New Hampshire. At a desirable waterfall a town was hewn out of the forest in 1838. There the three Stark Mills and two Amoskeag were operating to full capacity by 1845, when the town called "Manchester"—a fitting name—had a population of 7,000. The expansion of the mills soon made Manchester the largest city in the state. Besides cotton, the Amoskeag plant manufactured wool goods and machinery—at one time it produced locomotives. In its cotton section the Amoskeag eventually owned the largest cotton factory in the world. Between Manchester and Lowell at Nashua still more large cotton factories were erected. About the same time as the founding of Lawrence

a project, mammoth for its day, was carried out to dam the Connecticut at Hadley Falls, and there the city of Holyoke was born. Although promulgated as a cotton manufacturing town, its claim to fame has been greater for its paper manufacture.

All of the promotions so far mentioned were more or less the work of a group of Boston merchants, commission men and capitalists, so the mills were often dubbed "the Boston Group." Outside of the factories of this interconnected clique, there was an equally notable building of factories along the banks of the Blackstone River. From Worcester to Providence this stream at every waterfall was clustered with textile plants, although some of them were wool mills. At Norwich, Connecticut, where two smaller rivers join to form the Thames River, cotton mills of large capacity were established, and along both affluent streams there were built smaller mills, some for wool, others for cotton manufacture.

In New Jersey, the original mills on the Passaic at Paterson were augmented by others at various power sites on that river until the river became the centralizing factor for one of the three most important cotton (and wool) concentrations in the United States. In Pennsylvania, in or near Philadelphia, the Schuylkill and smaller creeks flowing into that river or into the Delaware echoed to the hum of the spindle or clatter of the loom. Manayunk, then on the outskirts of the Quaker City, shared with Lowell and Paterson the distinction of being the outstanding cotton manufacturing communities in America.

The Lowell and Providence Systems.—Between these various water driven mills scattered from Maine to Delaware there was a sharp cleavage as to manufacturing processes and practices. Those north of Boston in Massachusetts, New Hampshire and Maine were said to follow the "Lowell System," while those of southeastern Massachusetts, Rhode Island, New Jersey and Pennsylvania fell in line behind Providence and hence comprised the "Providence System."

The Lowell System was directed from the counting-houses of Boston. The men who ruled it were business men and investors. They turned at first to cotton because their investments in

commerce were unproductive during the Embargo and Non-Intercourse period of 1807 and 1809 and again during the War of 1812. By 1834 seven-eighths of the merchants of Boston were identified with New England cotton mills as stockholders, directors or agents. The factories were guided by the black and red figures in day books, ledgers, and on balance sheets. None of the promoters were practical manufacturers and neither were the agents (general superintendents) in direct charge of the mills. At Lowell, for example, in 1845, not one of the ten agents was a specialist in manufacturing; indeed, six were lawyers. Inspired by Francis Cabot Lowell, all the men who guided the Lowell System invented or hired inventors to produce machinery for the factories. Of course, they started with the basic ideas of the English inventors, but the details of the Lowell System machinery were original and surprisingly profitable. This machinery was all patented and manufactured by the Lowell System for itself.

Debarred from the use of the "Lowell" machinery, the men of the Providence System had to invent their own or import British models. Having started with the Arkwright machines built by Slater, they clung tenaciously to British practices. The power loom being first installed by the Lowell group and belonging to it by patents, gave this aggregation a primary advantage over the Providence men. But the latter, within three years of the start of the Boston Manufacturing Company at Waltham, invented another power loom. This was really a loom copied after a Scotch pattern by a Scotch immigrant named William Gilmore, who made minor changes in the loom to fit it to American conditions. The Providence group were men trained by mill experience as manufacturers, were residents at their properties and gave such careful scrutiny to production rather than accounting that they easily surpassed the Lowell System in *quality* of output.

The Systems Contrasted—The Lowell System: 1. Capital.
—The Lowell System was capitalistic, financed by joint-stock associations. While the interested merchants owned enough stock to exercise control they did not have to sink a great deal of their own money in the enterprise, because the stockholders were so widely scattered and held so few shares each. For example, the

Merrimac Company of Lowell, in 1845, had 390 stockholders, distributed as follows :

Merchants and Traders	46
Females	68
Retired Business Men	52
Administrators, Executors, Guardians, and Trustees . . .	80
Lawyers	23
Physicians	18
Literary Institutions	3
Farmers	15
Secretaries, Clerks, and Students	40
Mechanics and Persons employed in the service of the Company	45
Total	390

Since the capitalization of the Merrimac Company at that time was \$2,500,000, the average investment per stockholder was \$6,410. We know, however, that the 45 mechanics, etc.—this is a notably early instance of employe stock ownership which many deem so modern—had together \$60,000 worth of stock, or \$1,333 each. If the other stockholders, except the merchants, participated at this rate, then the merchants each had \$43,478 invested, which is probably an overstatement of their shares. The whole table is interesting because it contains so many classes of investors akin to those now found in our great corporations; namely, the “widows and orphans,” estates, institutions, professional men and employes.

That the Merrimac Company was not unique is indicated by the statement of the capitalization, in 1849, of other companies in the “Lowell System.” In the city of Lowell four other mills were capitalized in excess of one million dollars. Two mills at Manchester, New Hampshire, two at Saco, Maine, and one at Nashua, likewise were in this class. Three mills at Lowell, three at Springfield, Massachusetts, and one at Nashua were capitalized at more than one-half million dollars.

Large capitalizations were necessary because ventures in cotton manufacturing involved, in addition to the erection of buildings and the purchase of machinery, the building of dams, canals, raceways, and the construction of whole towns, including houses, stores, churches and banks.

Rapid Improvements.—Besides the huge capital needed for the original investment, a generous portion had to be allotted to improvements and betterments, especially in machinery. Since the average length of service of labor in the mills was only four and a half years, little reliance could be placed upon the accumulated skill of the working force. On the contrary, each manufacturer was faced with the necessity of teaching a constant succession of "green help." Inasmuch as there was slight dependence upon labor, employers were forced to become inventors and transfer skill to the machines. The immense output of cotton goods rewarded the smallest improvement. The introduction of better methods met with no opposition from labor as in England, because in the United States machines neither deprived anyone of a living nor upset long-established trades.

One way of showing the technological improvement is the number of yards of cloth purchasable for a given amount of money. If we take the amount earned by a woman in one week, then the comparison of what she could buy in cotton goods in 1815 and 1850 would be

	1815	1850
Ticking.....	1 yard	23 yards
Sheeting.....	2 yards	35 "
Calico.....	2½ "	30 "
Shirting.....	2½ "	39 "

Another more accurate method by which the improvement in machinery may be manifested is by comparing the ratio of spindles to operatives. Slater's mill of 1790 had a ratio of spindles to operatives of 8 to 1. In 1831 the ratio of spindles to employees was 22 to 1; in 1880 this had become 62 to 1, and in 1914, 80 to 1. In Massachusetts in 1919 the ratio was 107 to 1, but for the nation it was 78 to 1. The slowing of the increase of spindles per wage-earner after 1880 is due in part to the advent of southern cotton manufacture and the decline after 1914 is to be attributed to the disturbance of the World War.

Success in cotton manufacture rested only with the man who raced to install new devices, and this new equipment became obsolete in five years. The manufacturer without money to adopt the latest inventions lost his trade and his mills. This struggle

for supremacy by means of mechanical devices compelled the business to be capitalistic.

The Lowell System: 2. Mass Output of Standardized Goods.—The merchants who ruled the Lowell System discovered for themselves that principle which we call typically American, namely, that great profit may come from large-scale operation in the production of a strictly standardized product. The largest mills of the "Lowell System" by 1850 contained generally 6,000 spindles, whereas mills elsewhere contained then as few as 300 spindles. These large mills of the Lowell System each manufactured just one commodity—for example, osnaburgs, drills, print cloth or brown sheeting, 37 inches wide. If a company produced more than one item it manufactured each in one mill devoted exclusively to one commodity, that is, sheeting in one mill and drills in another. Some factories ran for years without a single change in the major adjustment of machinery or the slightest variation in their product. This saved one of the big costs of cotton manufacture, namely, alteration of machinery to make a different article. It also provided definite training of the "help," which became proficient in doing one thing in the relatively short time the "help" remained in the factory. And by reason of the practiced labor the machinery could be operated at higher than normal speeds. That these methods paid is evident by the record of dividends which ranged from 15% to 30%, after a comfortable surplus had been laid aside and after new factories had been erected out of earnings.

The Lowell System: 3. Labor.—The factory girl in the early days at Lowell, Manchester, New Hampshire, Saco, and the like, belonged to the type that now fills the ranks of school teachers or stenographers. Most of the girls came from old American stock and many of them became the wives of community leaders and the mothers of men and women who later stood at the forefront of American affairs. So carefully were the mill girls safeguarded that Lowell became the model factory town of the world. The mill windows had dainty curtains and flower boxes on the ledges. The *Lowell Offering*, a paper writ-

ten, edited and published by the girls employed in the mills, is evidence of the high quality of the operatives.

In the factories of the Lowell System children were seldom seen, partly because the founders objected to child labor on principle, and partly for the reason that very young people were unprofitable employes. The investment in machinery was heavy. If it was not utilized to the fullest capacity much loss was incurred. Children could not keep pace with the speed of the machines nor take care of the maximum number of spindles. Moreover, the Lowell capitalists owned boarding-houses as well as factories; to get a reasonable return on the money invested in the houses the workers had to be able to earn sufficient wages to pay board and rent that would yield a profit to the landlord. The fact that children could not earn enough to pay for the space and food they consumed in the boarding-house was another reason why the factory-owners discouraged every attempt to force children into the mills. There were plenty of full-grown young women anxious to work, who, while in the factory, produced more yarn or cloth and, when boarding, could afford a relatively high rate; why then bother with child labor?

Foreign Labor.—The high grade of the early American cotton factory labor unfortunately was not maintained. The first employes were natives and came from superior families; in 1826, for example, of the 612 operatives at Fall River, only 38 were foreigners and 28 of these were in the print works. In 1842 at the Merrimac Mill of Lowell employing 1,500 people, only 50 were foreign-born and these were all British. But soon thereafter a change crept into our working forces; Irish immigrants began to flood the cotton mills in 1846, followed by thousands of French-Canadians who, in turn, have given place to hordes of Portuguese, Poles, Italians and Greeks. Today Manchester, New Hampshire, is a French-Canadian town with French as familiar a language as English. In 1918 it had a French-Canadian mayor who was forced to hire an interpreter for his official English correspondence. A section once known as McGreggorville is now called Notre Dame, and a new residence district has streets named for French generals. Lowell mills are now manned predominantly

by Greeks, the Lawrence mills by Italians, and the New Bedford factories by Portuguese, Poles and French-Canadians.

Low Wages.—The cause for this change lies in the development of machinery to offset the constant fluctuation in the original native working force. A machine made so simple in operation that an untrained American girl could in a short period operate it successfully, paved the way for the employment of immigrants when the American standard of living was raised. The result is that wages have been kept down because each successive wave of immigrants has had a lower standard of living than the one that preceded. Inasmuch as the nationalities were mixed and often antagonistic, there was no common ground of blood or religion to form a basis for unions to raise wages by concerted action. Except for mule spinners' unions formed among English and Scotch workers at Fall River in the eighties and nineties, and I. W. W. organizations at Lawrence after 1900, there has been scarcely any united effort to raise wages by New England cotton-mill workers. Although the United Textile Workers Union after 1910 strove valiantly to organize the cotton-mill employees, the effort lacked notable results.

Providence System: 1. Capital.—In the "Providence System" large capitalistic joint-stock enterprise played a minor rôle. There were some capitalists who owned factories or power sites and rented them to practical manufacturers, and there were joint-stock associations; but most of the mills were owned and operated by individual proprietors. Hence, the factories in the Providence System were far more numerous but smaller than those in the rival Lowell System. Generally, the proprietors of the Providence System put their factories in or close to existing towns and cities and so had no unusual capital outlay for the conversion of a forest tract into a civilized community. Some even rented the mills they ran.

Providence System: 2. Quality and Variety the Aims of Production.—The "Providence" owners too, as a rule, did not standardize their output nor show keenness for large-scale production. Rather, by close individual attention, they manufactured

a variety of fabrics of a distinctly superior quality to those of the Lowell group. As we have said, the machinery of the Providence System was usually British or of a British type.

Providence System: 3. Labor.—Besides introducing English machines, Slater carried into his mills English labor practices. As in England, so in Providence, the whole family was employed in the factories. Little children were especially sought because they were both deft and cheap; the first nine people hired by Slater were seven boys and two girls, all less than twelve years of age. In the older settled towns and cities where the factories of the Providence type were located, the deficit from children's work fell largely on their families; hence, the manufacturers gained by employing the little tots. To be sure, they had the lightest of jobs, that of providing materials for the operatives of the machines, which took about 15 minutes in an hour, or else they were sweepers and cleaners.

Slater brought into Providence also, the system of payment in kind rather than in money. He established a company store and issued checks good at that store where the people actually exchanged the sweat of their brows (or their children's) for tea, sugar, flour or dry goods. This scheme has inherent in it the possibility of unscrupulous injustice through the manipulation of qualities or prices of goods at the store; it makes possible real wage slaves. The Lowell mills from the beginning paid wages in money and helped fix that system in America.

The paternalistic regime at Providence deviated from the capitalistic rule at Lowell in the attitude of the employers toward their responsibility for the morals of their work-people. Slater established the first Sunday School in America at his factory, but the girls of Lowell built their own churches, organized their own debating societies, and published their paper without direct aid from their employers. The Lowell factory-owners reasonably safeguarded the morals of the boarding-houses, but aside from that the workers were responsible to themselves. The paternal attitude evidenced by Slater and the group that followed his example was heightened, of course, by the youthfulness of their working force.

British Contrasts.—Just as there were elementary differences between the Lowell and Providence mills, so also were there contrasts between the American cotton factories and the British. The fundamental factors influencing our establishments were cheap water power and raw material, while England's advantage lay in skilled but cheap labor. These divergences showed themselves in the adoption of machinery, the speed at which machines ran, the quality of product, and the type of labor employed. Where the English accomplished results by hand-labor we used machines, since our labor compared with the British was scarce and high-priced while machines could be operated cheaply. Power cost us only one-fourth what it did the English because we used water where they burned coal; we could be prodigal with power while they were forced to conserve it. This showed itself in the means employed for the transmission of power; our machines were belt-driven instead of being geared as were the English, because belts gave greater speed although at a greater expenditure of power. Paul Moody, in 1828, at Lowell, was the first man to use belts to drive cotton machinery, but the practice soon became universal in the United States. In the ordinary fortnightly wage period an American throstle warp-spinning machine produced 10,080 pounds of yarn, but the English had to be content with 6,345. Again, the United States turned out 63 hanks per spindle, where England's product was only 47.

Higher Quality.—England came to the fore, however, where quality rather than quantity was concerned. For one reason, our dry climate aggravated the generation of electricity by the machinery—fast-moving belts and the like—and as a result the yarn was coarser and rougher than the English. However, our market made less demand for the finer grades of yarn.

But the chief cause for the better quality of English yarn was the difference in labor. English labor was homogeneous and spent a lifetime in the mills. This cut the cost of foremanship and, at the same time, intensified the training of the work force. The workers were painstaking, highly efficient and turned out the best quality of goods.

English labor was skillful enough to spin yarn two or three

times as fine as the best we could furnish. The reason is connected with the fact of the predominance of women in American cotton factories. Whereas in England at the period referred to female cotton workers exceeded male workers by only 9%, in the United States they exceeded the male workers by 110%. But the finest yarns are spun on "mules" which require high-grade male labor. Since we did not have male labor we could not do "mule spinning" at all up to 1830, and for a generation thereafter, "mule spinning," while common in the Providence System, was almost unknown in the Lowell System.

There was a difference between the two countries, however, in the character of their female labor. In England it cast a stigma upon a girl's name to be known as a member of the mill group, but in the United States the best young women of the community were encouraged to enter the factories. The only pleasant thing Dickens said about the United States in his "American Notes" was the tribute paid to the women factory workers at Lowell. A generation later, it is true, Dickens could not have been so complimentary, for our cotton factory employes had changed in racial stock and in relative standards of living. The difference in attitude toward the workers in the two countries may well be exemplified by the terms generally used concerning them; in England they were called "hands" and "servants," but in America they were known as "helps."

British Specialization.—The cotton industry of the two countries reflected also the differences in age and economic development and trade interests. Old England had to contend with the long-established, hand-trade customs when mills were set up, with the result that her factories like her artisans specialized upon spinning or weaving; few plants did both. In young America, without settled artisan classes whose customs and prejudices had to be considered, cotton-mills since 1814 have usually performed all the operations for cloth production under one roof. England, too, primarily interested in foreign trade, was forced to manufacture a variety of lines and so had a number of small plants which specialized in variety production. The American mills had one great domestic market whose needs were for standard cloths.

England specialized, whereas we standardized. The three great centers, Manchester (England), Lowell and Providence, represented three types of industry, for although the Manchester and Providence systems resembled each other, each was stamped definitely with its own national characteristic. The Lowell System was distinctly American.

CHAPTER XIV

NORTHERN COTTON MANUFACTURE—ERA OF MECHANICAL POWER

Steam Power.—After the founding of Lowell upon the basis of large-scale water power utilization and capitalistic enterprise, no new element entered cotton manufacture until 1850, when coal first threatened the supremacy of water. Although steam had been used as early as 1801 and Slater in 1827 had installed engines at power-starved Providence, water power was so cheap that steam could not hope to compete with it. The cotton mills at Manayunk, in Pennsylvania, directly overlooked the Schuylkill Canal upon which anthracite coal was borne to Philadelphia, yet these factories ignored the coal passing under their windows and operated with cheap water power.

General Charles T. James, an engineer and builder of cotton mills, was the great prophet of steam-driven cotton factories. He gave a series of lectures on the subject at Newburyport, Massachusetts, in the late thirties. This city was in a receptive mood because with her shipping and commerce vanished to the superior facilities at Boston, the community was heavy with the odor of decay. Having no adequate water power, she could not resurrect herself by means of cotton factories until James held before her eyes the glittering promises of fortune that awaited the place which established steam cotton mills. Immediately after James' departure, the citizens of Newburyport set about the organization, erection and operation of the Bartlett Mill No. 1. James did not see this mill nor have anything to do with it until its dismal failure caused the projectors to send for James to doctor the sick patient. He reorganized it and, in addition, planned, constructed, and ran for a time Bartlett Mill No. 2. Under his tutelage both mills succeeded. By 1850 there were six steam mills at Newburyport, all planned and constructed by James.

The news of James' remarkable abilities in reviving an expiring town travelled to other ailing New England communities and his services were commanded by Salem, Portsmouth, in New Hampshire, and Newport, Bristol and Warren in Rhode Island. Learning of the new era opening for coal-driven mills, enterprisers at Lancaster and Pittsburgh in Pennsylvania, and Cannelton in Indiana, employed James to construct cotton factories in those places. Between 1840 and 1850 James was instrumental in starting 23 steam mills, 16 of which were in New England's old port towns. One of these, the Naumkeag Mill at Salem, was at that time the largest in the world to carry on under one roof the entire process of converting cotton into cloth. It contained, when it started, 31,000 spindles. These steam mills of James, too, upstart as they were, had the audacity to win the most prized medals at annual expositions of cotton fabrics.

Then the furious gods of wrath descended, lashing James and his steam-driven mills. The contest finally narrowed to a debate conducted in print between General James and A. A. Lawrence, the spokesman for the water-driven mills. This debate centered on the comparative costs of water versus steam power, and the alleged profit or loss in the actual experience of the decade in steam mill operation. Each side challenged the data of the other and made acrid personal insinuations as to the motives for the stand each took. Meanwhile, the improved steam engines were overriding waterwheels.

Steam Power Triumphant.—Soon it was demonstrated that the crux of the competition between the two powers was not the relative cost of steam versus water power, but the inelasticity of water power compared with steam. The limit of expansion of mills at a water power site was the maximum water power available at that point. Stream flow and hence, water power was irregular; it varied from year to year, and in one year between seasons. Both flood and drought stopped the mills. By 1830 the smaller streams had been developed to their utmost capacity. Ten years later the Blackstone had along its banks 94 cotton factories, 22 wool mills, and 34 machine-shops, crowding every available site and exhausting the last drop of energy in the stream. Even

Lowell had to supplement her water power with steam auxiliaries in 1845. So it was not so much a question of comparative costs where water was obtainable, as it was the ability to expand with the growing demands of the market. Mills driven by water were held within the bounds of the capacity of their particular site; beyond that they could not grow.

Meanwhile, steam engines were being improved rapidly so that their cost of operation was lowered at the same time that their efficiency was raised. Installed as an aid to help carry the overload of water-driven factories, they gradually assumed the major burden, and relegated water power to the subsidiary position. Moreover, steam power enabled mills to be located in any community regardless of water power, and it was in such places where no water power at all was used that steam-driven mills flourished.

Seaboard Mills.—General James not only advocated steam power but asserted that the ideal location for mills was a seaport where coal could be laid down cheaply by barges. Newburyport, Portsmouth, and the others of those first developed have not so ably and strikingly demonstrated the truth of James' theories as have the mills built at Fall River and at New Bedford. Notwithstanding that Fall River's earliest mill was established in 1813 in imitation of Slater's in near-by Pawtucket, and that the town was endowed with a small stream whose rapid fall in a short distance gave the town its name, nevertheless cotton manufacture was of little consequence there until after 1865. Fall River's prosperity was founded on coal power and not upon the influence of its little river. Situated upon an arm of Narragansett Bay, coal was brought by barge almost to the mill doors. Since water transport was cheap, this made the first cost of coal at Fall River low, and it also saved an expensive inland railroad journey. On the other hand, coal used at Lowell was shipped to Boston and there transferred to the railway cars for haulage to Lowell. In Fall River, furthermore, there was no check, so far as power was concerned, to the growth of cotton mills because steam engines could be multiplied at will.

Damp Climate.—Although steam power was a fundamental factor in the prosperity of the seaboard cotton mills, there were

other reasons that were of vital importance, chief among which was the matter of climate. Atmospheric conditions are of the utmost importance in cotton manufacture, since a high degree of humidity is necessary for fine spinning. The rubbing that yarn gets in spinning creates frictional electricity which causes the strands to tangle. Moist air being a good conductor helps to carry off this electricity; aridity, on the contrary, not only fails to remove electricity but aids in its production. Humidity increases the elasticity of cotton because the yarn absorbs moisture up to 35% of its weight. A damp yarn spins easily since it is not apt to snap or curl; accordingly, the output of a spinning room varies from 5% to 10%, conformable to the dryness or wetness of the air. A similar fluctuation is noticeable in weaving, for if the air is dry the warp threads break constantly, causing frequent stoppage of the loom, which increases cost by reason of the lessened output. Aside from these effects on the yarn and cloth, dampness influences the standardization of the belts, Jacquard cards, loom harnesses and shuttles. As a consequence of all these factors the air in all cotton-spinning rooms is kept saturated.

By the borders of the sea this desirable atmospheric condition was produced by the presence of the ocean itself, whereas inland mills were forced to depend entirely upon artificial means. A New Bedford mill could work frequently with its windows open because the air was naturally in the proper condition, but at Lowell, or at Manchester (New Hampshire), a factory must lock its windows, spray steam into the rooms, and compel its employes to work in this stuffy, confined atmosphere. Since health and economy both were promoted in mills near the coast, nearly every great textile center is in such a location. Bombay, in India, the towns in Lancashire, England, Philadelphia in Pennsylvania, and southeastern Massachusetts, are all good examples of locations possessing naturally this necessary atmospheric condition.

Resident Owners' Seaboard Mills.—Both Fall River and New Bedford were at first developed by local capital, while on the contrary, the mills of Lowell or Lawrence were the property of non-resident capitalists. The men who owned the factories at Lawrence seem to have had little interest in the place as a social

community. This indifference was tolerable if the working people had been born in Lawrence, or owned homes of their own; but with the population so largely foreign born there was no group whose interest in Lawrence was sentimental rather than financial. New Bedford, despite its large alien population, had a coterie of old families that possessed a personal attachment for the old whaling town. Absentee landlords seem to have been as socially detrimental to American cities as to Irish farms.

Because of these things—personal interest of inhabitants, naturally favorable climate, and advantageous location in respect to coal—the coastal cotton centers advanced far beyond the earlier established inland mills. Fall River, with over 100 cotton mills, held undisputed leadership for a number of years; then after 1910 New Bedford jockeyed its neighbor for this distinction, first one surging to the front, then the other. New Bedford, when it could not claim to make the most cotton, correctly asserted its title to manufacturing the *finest quality* yarn produced in the United States. Fall River, although it did produce some fine goods, relied upon mass production of medium and low grade fabrics. Since 1880 these have had to meet the intensive competition of the South, so that in recent years Fall River has been threatened with extinction. New Bedford, on the other hand, has been serenely indifferent to southern competition.

Localization in New England.—In all the United States, in 1925 there were 14 counties having more than 500,000 cotton spindles. Of these, 10 were in New England, 6 being in Massachusetts, 2 in Rhode Island, and one each in Connecticut and New Hampshire. The leading county for the nation was Bristol, Massachusetts, in which Fall River, New Bedford and Taunton are located. This county, in 1925, had 7½ million spindles; 41% of the total for New England and 19.8% of the national total. The county of Providence, Rhode Island, cheek by jowl with Bristol County, was second in the nation with 1,800,000 spindles. Middlesex County, Massachusetts, which spreads fanwise around Boston, was fourth with 1,100,000 spindles. The New Hampshire county of Hillsboro, in which Manchester is located, ranked sixth with 897,000 spindles. The other New England counties

which were in this exclusive company were Hampden, of which Springfield is the center; Worcester, whose name is the same as its leading city; Windham, which lies south of Worcester in Connecticut; Essex, which contains Lawrence, Salem, Ipswich and Newburyport; Kent, which is south of Providence in Rhode Island; and Berkshire, on the western boundary of Massachusetts. New England, therefore, held title to national leadership in cotton spindle capacity.

Electrical Power.—Steam power for the operation of cotton factories was but slightly challenged until after 1900. By 1910 it was evident that electrical power was to become a serious rival of steam. After that date electrification swept forward so rapidly that by 1923 electric motors furnished more primary horsepower to cotton mills than steam engines. In a quarter century the horsepower delivered by motors actually surpassed that derived from steam engines and steam turbines. Indeed, no other manufacturing industry except the iron and steel equalled the textile groups in enthusiastic reception given to this motive power. The steel industry uses three times the electrical horsepower of the textiles, but the latter employ from 25% to 50% more than the other leading users of electrical power. Cotton manufacturers almost doubled their electrical horsepower between 1914 and 1919, and by 1923 had multiplied by more than two the electrical horsepower used nine years earlier.

Power Transmission by Electricity in Cotton Mills.—A cotton mill usually comprises two sets of buildings, one several stories high for spinning, and the other one story in height for weaving. To gain light the spinning mills are narrow, while the weave sheds with saw-tooth roofs are very broad. With both types of construction the *transmission* of power is difficult and costly. The best spinning mills before 1910 generally had a separate tower in which ran rope or belt drives, the power being taken off at each floor and distributed to the machines by shafting. The approved weave shed carried the power shafting under the floor. Through slits in the floor at the machines, belts took the power from the shaft.

To effect economies in transmission, the first use of electrical power was to place a motor in each work-room or a motor at the head of each line of machinery. The power tower then was equipped with electric cables instead of the running ropes or belts. The existing shafting in each room was undisturbed. The cotton mill was able to use electricity in this way for power transmission because relatively small motors could carry the power load of the room full of textile machines, for most of the individual machines had small power requirements. Warpers needed, for example, from $\frac{1}{4}$ to $\frac{1}{2}$ horsepower, sliver cap machines, combers, and looms each about $\frac{1}{2}$ horsepower. The largest machines did not exceed 12 horsepower and these were confined mostly to the processes preparatory to spinning. The ordinary requirement per machine was 1 horsepower.

Two technical advances in electrical engineering prefaced the next step in electrical installation in cotton factories. One was the construction of large-sized dynamos for direct connection either with a steam turbine or a water turbine; the other was the manufacture by electrical machinery companies of industrial motors of small horsepower capacities. The first enabled a cotton mill, without changing its primary power plant materially, to produce electric current cheaply. The second permitted connection of each individual machine with its own motor.

Individual Motors in Cotton Mills.—Separate motors per machine were a big step forward in cotton manufacturing. All the overhead shafting and belts were removed, at once admitting more light, eliminating much dust, oil and noise, and reducing the hazard to life and limb, all of which were important factors in the manufacture of quality yarn and cloth. The motor on the machine allowed the operation of each machine as a unit, its power accurately measured and delivered uniformly. The latter was a vital point for quality varied directly with evenness of power flow. It was because the steam engine was more regular than water wheels that James' first steam mills carried off prizes for quality cloth. The steam turbine coming later was more uniform than the reciprocating engine and hence more approved in cotton mills whose

output was sold on the quality basis. The electric motor was the most consistent performer of all.

Making or Buying Electrical Power.—After the separate motor per machine had proved its worth both in economy of power and in quality of production, the cotton manufacturers were faced with the problem of the relative merits of producing their own power or buying it.

In favor of purchased power was the fact that the cost of power was the smallest item in the total costs of manufacturing cotton, amounting to a fractional part of a cent per yard of goods. For fine quality yarn and cloth the power item was even less important than for coarse. The capital and space required for a power plant, if put into spinning and weaving machinery, could earn enough extra in some mills to pay for all the power for the whole works. The expansion of electric power companies and their knotting together in superpower systems made current both certain and cheap. That these arguments appealed forcibly is shown by the record of the years between 1914 and 1923. In these years the horsepower of electric motors driven by current generated in the cotton manufacturing establishment advanced merely from 260,000 horsepower to 437,000 horsepower, whereas the horsepower of motors driven by purchased current jumped from 250,000 to 830,000.

On the other hand, many manufacturers already had power plants which represented heavy investments, and which, if discarded, could not be sold for anywhere near their worth in place in the factory. Again, those mills that were favorably situated in reference to water power not only could easily develop hydroelectricity for their own use, but sometimes a surplus for sale. A few fortunate cotton mill enterprises sell hydroelectric current so advantageously that it pays all and more of their own power costs. One or two of these mills might well abandon cotton manufacture and derive their income from sales of power. Of course, cotton mills, even if they purchase power, must operate boilers for heating the mills and for certain processes. In a mill producing its own electrical power by steam these uses of steam are gained as by-products.

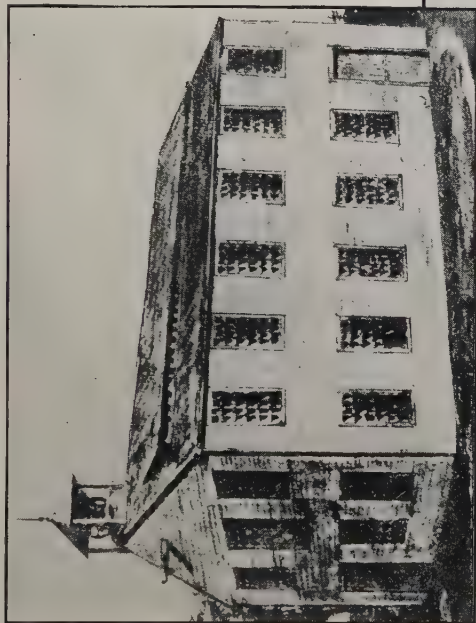


PLATE 10. The Slater
Cotton Mill of 1793
at Pawtucket, R. I.

(Courtesy Mrs. H. L.
Spencer, Bristol, R. I.)

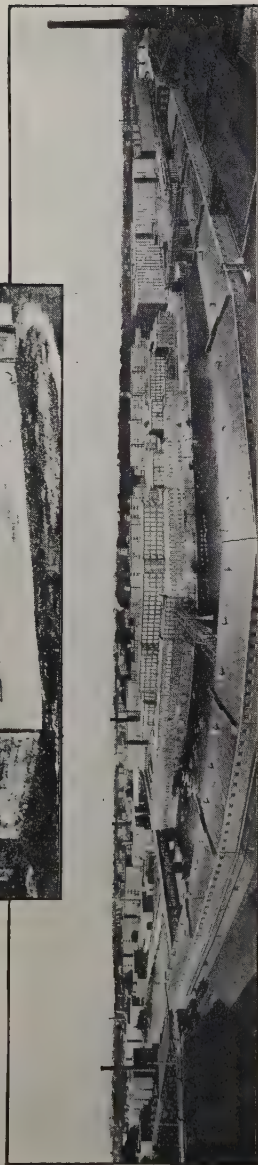


PLATE 11. The Amoskeag Manufacturing Company of Manchester, N. H. The cotton mills of this corporation
are the largest in the world.
(Courtesy Amoskeag Mfg. Co.)



(Courtesy
Graniteville
Mfg. Co.)



(Courtesy
Kendall Mills,
Inc.)

PLATE 12 (*upper*). The Original Mill (1845) of the Graniteville Manufacturing Co., of Graniteville, S. C. The oldest continuously successful cotton manufacturing company in the South.

PLATE 13 (*lower*). The Mollohon Manufacturing Co., Newberry, S. C. Subsidiary of Kendall Mills, Inc., Boston.

Internal Combustion Engines.—As late as 1919 the internal combustion engines—the gas engine—had won scant attention from cotton manufacturers, but in the four years following the amount of horsepower derived from this type of prime mover in cotton factories was multiplied by 5 (2,842 to 14,435). The gas engine is still the least of all cotton mill power producers, but it has significance for the future. Except the Diesel engine, gas engines to date have been of small power capacity. Hence, in cotton factories they have furnished auxiliary power rather than performing the principal power service. They stand where steam engines did in 1840, and are used in the same types of mills for the same work as the steam engine was at that time.

Monopoly in the Cotton Industry.—The first to enter the factory system, and thoroughly mechanized, it might be expected that cotton manufacture would evince tendencies toward monopoly. Yet this never has occurred.

The makers of cotton goods can gain no monopoly by control of raw material, patents on machinery, or dominance in the channels of distribution. American mills consume more than 6 million bales of raw cotton. To control the production of this amount would require 20 to 25 million acres of land, or an area greater than the entire state of South Carolina. In the United States alone there are nearly 43 million acres devoted to cotton, which easily could be increased if monopolistic control of 25 million acres raised the price of raw cotton. But it is unthinkable to suppose that cotton manufacturers would sink the capital and undergo the complexities of farm management merely to control raw cotton.

Cotton manufacturing machines, with a few exceptions, are not patented, as a whole. Small adjustments to the machines are patented. But the cotton manufacturers, although some at first made textile machinery—Lowell, in Massachusetts and Manchester in New Hampshire, being cases in point—do not now commonly do so. If they did they could not monopolize cotton manufacture, for British and German machines would offer competition.

So far as distribution of cotton goods is concerned there is

nothing upon which to base a distributive monopoly. There are two markets for cotton goods, first, internal, within the textile trade—yarn mill to weaver, cloth maker to finisher—and secondly, external, from the whole group of cotton mills to cutters, jobbers, selling agents, commission men and retailers. The variety of cotton woven goods has at least 19 classifications, within each of which the subclassifications run into thousands. No corporation could be gigantic enough to cover all these fields, and if it did, it would invite immediate competition. For the transportation of cotton yarn and cloth no specialized facilities are required.

Cotton manufacture is capitalistic but this fact warrants no ground for monopolistic production. The normal capital investment per spindle has ranged from \$25 to \$50, varying at different times and for different classes of product. The average spindles per establishment have reached from 14,000 to 20,000. That is, the ordinary investment in a spinning establishment may be from \$350,000 to \$700,000. Similarly, weaving mills may call for an investment of from \$200,000 to \$350,000. A New England spinning mill of 50,000 spindles according to reliable estimates could, in 1926, be built for two million dollars, and a weaving shed with 1,280 automatic looms for one million dollars. These are all relatively small investments for relatively large-scale cotton manufacturing plants. The sums are so small that any marked advance in the price of cotton goods set by a monopoly would at once invite others to enter the business. But one may begin spinning on an investment as little as \$50,000, and there are scores of small weaving establishments in or near Philadelphia that started with an investment of \$3,000 and could be duplicated at any time; for weaving may be done almost on a one man basis in rented quarters, operated with rented power and the product sold by consignment.

Throughout much of the range of cotton products style is a factor. Wherever this is true in any industry, the result is likely to be relatively small-scale production. Styles shift overnight. To catch popular whim a factory must be small enough to change its machinery in accord with the mode. Since a large plant finds this costly, most large-scale operations are on standardized non-style goods. On the contrary, an enterprise with few machines

may alter them quickly and ride on the wave of profits that comes from catching public fancy when the public is most eager to purchase. Therefore, in so far as style is a factor in cotton manufacturing, it tends to keep factories within small compass.

Combination in Cotton Manufacture.—For these reasons no one ever has dreamed of establishing a monopoly in cotton manufacturing. There have been, however, several efforts at combination of producers in some one particular branch of cotton manufacturing. Among the most complete was the American Thread Company, organized in 1898. Before that time the British thread makers, under the leadership of J. & P. Coates Company, had set up the English Sewing Cotton Company, which ruled the output and sale of this article in Britain. Representatives of this corporation came to the United States and induced the leading manufacturers of thread to join together, the result being the American Thread Company. This, in turn, was made subsidiary to the English Sewing Cotton Company.

A handful of manufacturers engaged in bleaching, dyeing and printing cotton cloth with plants in Rhode Island, Connecticut and New Jersey, formed in 1899 the United States Finishing Company. This organization has not confined its operations to cotton, but including its non-cotton product it never has finished more than 25% of the cotton cloth of the United States. In truth, there are individual factories that print or bleach a greater yardage than the "combination."

The only deliberate attempt at combination to effect a monopoly in one branch was taken in 1901, when the United States Cotton Duck Corporation united 12 firms owning 16 mills manufacturing cotton duck. Four years later a reorganization and enlargement occurred, the title becoming the Consolidated Cotton Duck Company. Failing to effect monopoly control even in the portion of the cotton duck business devoted to sail cloth, the Consolidated turned from manufactures, although it retained its mills, to effect its purpose through selling, and so added selling houses to its group. The company then, in 1910, became the International Cotton Mills Corporation, important only for its control of certain popular brands. The square yardage of cotton

cloth made in the United States is 8 billion. Of this, cotton duck is only 68 million. Duck for sail cloth comprises about 10% of all duck made and the International Cotton Mills Corporation did not at any time manufacture and sell more than 90% of the country's sail duck. As a monopoly in cotton manufacture, therefore, this was a *diminuendo*.

Combination for the purpose of large-scale production without thought of monopoly has been going on in the cotton industry ever since the Boston Manufacturing Company of Waltham was allied to the Merrimac Company of Lowell. After combination most of these mergers have been relatively small but a few have attained considerable spindle capacity. As these lines were being written in 1927, it was rumored in the trade that 50 southern cotton mills were to be brought into one combination. The maximum possible spindle capacity of this combination would be less than half the spindle capacity of Bristol County, Massachusetts. Neither monopoly nor excessively large-scale production has been characteristic of the cotton manufacturing industry.

Cotton Manufacturers' Association.—The loose alliance of cotton manufacturers for mutual interchange of information and the promotion of the spirit of cooperation began in 1854, when the Hampden County Cotton Spinners Association was established in Massachusetts. Eleven years later this was enlarged and renamed to fit the expansion of the industry, becoming the New England Cotton Manufacturers Association. It then had a membership of 44. In 1906 because of the geographic spread of membership, the association was named the National Association of Cotton Manufacturers. By 1926 its enrollment numbered 1,626 and included manufacturers in the Middle Atlantic and Southern States and a few foreign members. The bulk of this membership, however, always has been in New England. It has published semi-annually the papers read at its meetings and, in 1918, began to issue a yearly manual and yearbook, a most valuable statistical compilation relative to raw cotton and cotton manufactures.

Southern manufacturers, the majority of whom do not belong to the National Association, have another of their own, called

the American Cotton Manufacturers Association. This was inaugurated in 1903 and is similar to the National Association.

These two associations met together in New York in June, 1926, and appointed a joint committee of ten to analyze the problems confronting their industry and to formulate plans for a national organization. Out of this effort there was formed, in the late fall of 1926, the Cotton Textile Institute, with Walker D. Hines, former Director General of Railroads, as presiding executive. The announced purpose of the Cotton Textile Institute is the collection of statistics and other information, the formulation of cotton manufacturing standards, merchandising plans and price data.

Belligerent Associations.—What might be called belligerent associations for the handling of labor problems, output troubles, and skipping difficulties, have been fairly numerous. The outstanding one in New England is the Arkwright Club—a luncheon club—organized in Boston in 1880. Its New England Cotton Freight Claims Bureau installed in 1906 has been very effective. There are two associations among southern spinners, one: the Southern Hard Yarn Spinners; the other: the Southern Soft Yarn Spinners. Both North and South Carolina have state cotton manufacturers' associations and Georgia manufacturers have organized the Georgia Industrial Association.

Although not belligerent, another set of associations should be mentioned. These are the Mutual Fire Insurance Companies. Nearly all the cotton manufacturers belong to one of a score of mutual associations for carrying fire hazards and authorizing mill equipment. For years, the Mutuels were housed together in one building in Boston.

Modern Problems—Raw Material Factor.—In cotton manufacture the two largest items in the cost of production are the cost of cotton and labor. Anything which disturbs either or both of these has a direct influence on profit and loss.

Production of American raw cotton began with 3,000 bales in 1790. Ten years later, the amount was 73,000; in 1810 it was 178,000, and increased rapidly each decade, so that by 1840 the

million bale mark was passed. In 1875 a 5 million bale crop was reached, and in 1897 twice that figure was attained. The years 1904 and 1906 saw a production of 13 million bales, and in 1911, and again in 1914, the record production of 16 million bales was made. Then the tide of production ebbed for nine years in succession, the lowest point being in 1921, when 8 million bales were all that were harvested; that is, a crop that went back to the figure of 1896. The crop for the three years following advanced but was from 2 to 6 million bales short of the 1914 record, until 1925. From 1914 to 1921, therefore, American manufacturers were faced with an almost continuous decline in the supply of raw material. To make matters worse, the crops for 1918, 1919, 1920 and 1921, and again in 1924, were distinctly inferior in grade.

The world situation paralleled the American. Until the Civil War we had a monopoly on the production of cotton used in factories where power machinery operated. But the sharp curtailment during the conflict between the states stimulated Europeans to find a source of cotton independent of the United States. India, Egypt, Russia, China, Brazil, Mexico, Peru and South Africa, all were exploited. None of these has ever reached more than a third the amount of the American crop. India, the original home of cotton, has come the closest, but most of the Indian cotton is consumed in India and, besides, is of inferior quality. Egypt produced the finest fiber in the world but the crop never has reached 2 million bales and the productive area of the Nile Valley is hemmed by deserts. China's crop is an unknown quantity and is used almost entirely in China and Japan. The other producing areas are negligible. Therefore, the world crop is dominated by the American production. Hence from 1914 to 1921 the world faced an almost constant decline in supply.

The highest price ever paid for upland cotton was in 1800, when 44 cents per pound was the average for the year. Ten years later the price dropped to 15.5 cents and by 1840 was down to 9.5 cents. During the Civil War and Reconstruction the price climbed back as far as 21.4 cents (1872), but thereafter slid downward to the low point of 6.1 cents in 1899. From that year cotton prices have tended upward. The slackened world supply after

1914, together with the real and fancied war demands, boosted the price.

That is, the present generation of cotton manufacturers who had grown up with the idea that 10 cent cotton was high priced have had to readjust their mental attitudes to cotton prices for which there is no precedent except the Civil War period and the decade from 1800 to 1810. In short, one of the two chief costs of cotton production has had a recent sudden sharp advance. If the average price of cotton for 1913 be taken as 100, then the price of cotton reached 320.6 in July, 1920, and only in four different months since 1916 has been anywhere near the 1913 level. But all other basic commodities went through a similar experience.

Cotton manufacturers could operate at a profit so long as the spread between the price of raw material and the price of finished yarn and cloth was maintained or increased. A careful scrutiny of the prices of the leading standard products would reveal that the prices for them leaped higher proportionally to raw cotton during the World War years and until October, 1920, than had ever before been known. That is, the "spread" increased, or the profit margin was widened.

But since 1920 cotton prices have remained high, whereas goods prices have sunk, not back to the 1914 level, but in the coarse goods fairly close to that point. Fine goods, which in 1920 were nearly 6 times the price per yard received in 1914, declined in 1926 to twice the price of the pre-war level. One reason for the retrogression of goods prices was a nation-wide "buyers' strike" in 1920-1921 and 1922 and the hand-to-mouth buying by consumers, retailers and wholesalers since that time. Another was the fashion for short and narrow skirts, and scanty underclothing. Demand has decreased. Mill capacity, on the contrary, was being increased prior to the World War and during that period was rapidly augmented. As a result, the cotton manufacturing industry was in acute distress after the autumn of 1920.

The Cotton Textile Institute was one result of this affliction. Manufacturers hoped through it to reduce the varieties of goods made and to have reliable information on which to base policies for production and sale. Another result has been the bringing

together of manufacturers of the same type of goods in sales promotion campaigns. Thus, in 1927, the principal makers of gingham agreed to act together for this purpose. A third consequence has been a diligent search for new outlets for cotton products. Naturally, the instant direction this took was the attempt to substitute cotton in public favor in goods made of other textile fibers or of leather. A longer range campaign was started by some manufacturers to gain foreign markets. A fourth effect was that some mill owners "gave up the ghost"; that is, plainly discouraged, they put shutters on their mills—some shutters bearing the disgrace of a sheriff's notice. Those who did not reach such extremes curtailed operation. We thus have marginal cotton manufacturers, who produce at full capacity only during booms. Most of these are in New England and some in Fall River.

Modern Problems—The Labor Factor—Wages.—Labor, one of the two chief items in the cost of production in cotton manufacturing, has been a worm slow in turning, but one which at last, not only rolled over but humped itself amazingly. The cotton industry more than any other failed to respond to the advancing standards of living in America by increases in wages. It was able to maintain the low levels set in previous generations by tapping the flow of immigration and substituting for nationalities becoming acclimated to American expenditures other more recent arrivals who retained their peasant set of values. If the wages paid in New Bedford in 1870 be taken as 100, then during the eighties and nineties the wages paid in that city ranged from 80 to 95. Except for 1892-1893 and 1902-1903, the 100 line was not crossed until 1907. It did not go above 106, however, until 1912. During the World War the workers in this industry, as in all others, were paid at constantly higher levels, so that our figure for New Bedford became 179 in 1918, and reached the high point of 313 in 1921. It has since receded, but only to 246. The story at Fall River is very much the same, except that all the levels are slightly lower than at New Bedford.

Changing our basis 100 from the wages paid in 1870 to the wages paid in 1913-1914, the 1925 wage at New Bedford was 210

and at Fall River 211. Figured the same way, the cost of living was 173 in 1925 as compared with 1914. On this showing the cotton operatives not only secured a greater number of dollars but also actually added to their "real wages"; that is, what their dollars could buy. To this conclusion there is an offset, namely, that the wage figures of 210 and 211 were *rates*. The part-time operation and less than 100% of capacity operation of many cotton mills since 1920 cancelled the rise in "real wages."

To the manufacturer, however, this record has a great significance. The experience of 1870 to 1912 was revoked; a new period of rising wages commenced. The manufacturer was debarred from his former practice of finding employes from among immigrants of successively lower standards because the recent immigration laws not only limited the numerical quantity of immigrants but were directly aimed at the types that the cotton mills had been accustomed to attract. The higher wage level stimulated some manufacturers to install more efficient machinery, and by closer supervision to gain more from each worker. High wages do not necessarily mean high labor costs, but in an industry so dominated by machinery as cotton manufacturing, high wages are most likely to be accompanied by high labor cost, since the output depends more on the machines than upon the operatives. This puts the emphasis upon improvement of machinery.

Modern Problems—The Labor Factor—Hours.—Although the first industry to operate on the factory basis, cotton manufacture generally has lagged behind the procession in shortening working hours. When the earliest campaign for the shorter working day was waged to substitute a 10-hour day for the agricultural hours "sunrise to sunset," the cotton industry did not schedule a 10-hour day until this period was common in other trades and industries. Likewise, the cotton industry resisted the reduction from 10 to 9 hours and then to 8 hours.

Shorter work hours have been obtained in the United States either by pressure from organized labor or by state legislation. The first method has been impracticable for cotton-mill employes, for they have had no strong union. There has been a stalwart Mule Spinners Union and a weaker United Textile Workers, but

neither of these has imposed its will on cotton manufacturers in the matter of hours of work.

Legislation upon hours of work under our political system is limited to the states. Shortening the hours of work by law for men has won little support from legislatures, but all except five states have enacted statutes controlling the working hours of women. This has been done under the "police power" of the state, by which it has the authority to legislate for the general good, and also under the state's powers of guardianship, for women being the mothers of future citizens are, in a sense, wards of the state.

Legal definition of hours of work for women may result in establishing the same hours for men. If women predominate or if the processes upon which they are engaged are intimately associated with the departments where men are employed, then the setting of women's hours of labor also establishes the men's work period. If men predominate, women are discharged when the state law limits the hours of female labor. The cotton industry is of the first type, for women not only outnumber men but the flow of materials is so closely connected between departments that all must run on the same schedule of hours.

Unfortunately, there is no uniformity of work period laws in the states where cotton manufacture is important. The legal working hours for women in these states, in 1927, varied from 9 to 10¼ hours per day, and from 48 to 60 hours per week. Alabama had no limitation either per day or per week.

In the five New England States where cotton is manufactured quantitatively there were three different legal working hours for women. In fourteen other states there were six variations. Those states that have the same number of legal hours per week may vary in hours per day.

Looking at the matter solely from the cotton manufacturers' point of view, the confusion in legal hours means a decided inequality in competition. The reason for this is that the output from cotton mills depends more on machine time and less on labor efforts than in any of the other leading manufacturing industries, except for the kindred textiles, wool and silk. In many industries the production is varied within considerable limits by the efforts

of the workers, hence a decrease of hours may be accompanied either by a maintenance of output or by an actual increase. This never has been true in cotton manufacture. Because the machinery sets the limits of output in this industry, the decrease in hours has the effect of decreasing the production. A cotton loom may run 98% of a day without a stop; in some mills they are not halted during the noon period when the laborer is at home. If a strand breaks, the loom automatically stops. In cotton spinning the actual hand work takes only from 2% to 5% of the whole time of the day's run. These margins are too narrow to enable labor by greater efficiency to raise the output materially when hours are reduced.

Cotton manufacturers may offset the threatened decrease in production when legal hours are reduced by installing more equipment, employing more labor, rearranging the balance between departments, and increasing managerial ability. The first involves a heavier investment, the second a padded pay roll, the third is costly and not very effective, and the last is open to all competitors in this highly competitive industry.

Consequently, a shorter work-day adds to cotton manufacturing cost since a smaller output must bear almost as great overhead expenses. With higher costs the limited mill is debarred from the market tapped by the low cost long hour plant, for the market swings on fractional parts of a cent per yard.

The most intense competition in cotton manufacture is that between New England and the three southern states of North and South Carolina and Georgia. The lowest legal hours are 48 in Massachusetts, and 54 in South Carolina, while the highest is 55 in Connecticut, and 60 in North Carolina and Georgia. The South, then, at present has an advantage over the North in the length of time the machinery operates. Within New England itself there is a margin of 12% between Massachusetts and Connecticut. This one item of hours of labor, therefore, is a complicating factor in interstate competition, and has a bearing upon the location of marginal producers. The lack of uniformity in legislation upon hours sets up different planes of competition between the states and so constitutes one of the most pressing prob-

lems to cotton manufacturers in states where socially the legislation is most advanced.

The cotton industry of the North now faces a condition in which the price of raw material has advanced, and the cost of labor has been upset by two movements, one the raising of wages, the other the decrease in legal working hours. At the same time, the market for cotton goods is restricted and the margin between the price of goods and costs of manufacturing narrowed. The North, for a long time the ruler of cotton manufacturing, is learning the truth in the adage that "uneasy lies the head that bears the Crown."

CHAPTER XV

SOUTHERN COTTON MANUFACTURE

Topographical Divisions of South.—The South has six distinct geographic areas: the Coastal Plain, the Piedmont, the Great Valley, the Blue Ridge and Cumberland Plateaus, the Mississippi Uplands and Bottom Lands. The Coastal Plain from north to south is roughly parallel to the sea, its inner boundary being a series of waterfalls where the rivers plunge from the Piedmont to the plain. This border is defined by the modern cities of Baltimore, Washington, Richmond, Raleigh, Columbia, Augusta, Macon and Columbus. The line drawn through these points is called the "Fall Line" and with fair accuracy separates the Coastal Plain from the Piedmont. The Coastal Plain from east to west has four sections based on differences in soil: the Lower, Middle, and Upper Plain, and the Sand Hills, the latter lying along the edge of the Piedmont. The Piedmont is a plateau sloping toward the sea and dissected by watercourses so that it resembles much of New England or southern Ohio and Indiana. The Blue Ridge on the west and the Fall Line on the east mark the limits of the Piedmont. The Great Valley lies between the Blue Ridge and Great Smoky Mountains on the east and the Cumberland Plateaus and Allegheny Front on the west; it consists of a number of individual valleys, the northernmost being the Shenandoah. The Mississippi Uplands comprise the slopes along the river and the ridges that rise to the plateau several miles back from the river. Between the two uplands lie the low swampy areas of the Bottom Lands.

Before the Revolutionary War the South shared the industrial experience of all the colonies. Household manufacture was everywhere common. Yet, even in that time there were differentiations based upon economic responses to geographic environment. Colonial settlement was on the Lower Coastal Plain and in the

Great Valley, with a trickle of pioneers penetrating the Piedmont both from the Coastal Plain and from the Great Valley. The Lower Coastal Plain was the seat of large plantations devoted to tobacco in Maryland and Virginia and to rice or indigo in South Carolina. The owners were "gentlemen" and the workers negro slaves. In North Carolina there were few plantations because the Lower Coastal Plain was shut off from the sea by a series of sounds and sand bars. The Piedmont was an area of small land-owners engaged in subsistence farming, with cattle the main source of income. The Scotch-Irish, Quakers, Germans and Huguenots constituted the racial stocks in the Piedmont and they possessed very few slaves. The Great Valley frontiersmen were kith and kin to the Piedmontese and engaged in the same activities.

The planters on the Plain did little household manufacturing, for they had staple crops readily sold for money with which they purchased necessities and luxuries. Here and there and, from time to time, planters trained a few slaves in the arts of spinning, weaving, and shoe-making, the products of which clothed and shod the field laborers. On the other hand, the small farmers and ranchers of the Piedmont and Great Valley, by the constriction of their environment, carried on all the household manufacturing that was characteristic of the North. So far as racial stock, social viewpoint, and economic organization were concerned, the Piedmont was a spear head of the North pushed into the territory of the South. In the colonial South, therefore, there were thus two types of settlers, with two distinct agricultural systems, and two attitudes toward manufacturing.

Revolution to 1810.—These differences were carried forward after the Revolution until about 1810. In that period, however, cotton was adopted as a commercial crop in the South, and this became a mighty lever that upset the agricultural and industrial foundations that had been laid. Cotton had been domesticated or was indigenous in America long before Columbus arrived off our coasts. He found the Carib Indians growing cotton and manufacturing it into clothing and nets. Spanish explorers and conquerors noted that cotton was produced and manufactured com-

monly in Mexico, and Cabeza de Vaca, in 1536, found cotton in what is now the southwestern part of the United States. Cotton was planted at Jamestown in 1607 and was introduced in the Carolinas in 1664 by some colonists from Barbados, but the first significant planting was on the peninsula of Delaware and Maryland. It spread inland and southward from this point. Seeds from the West Indies, Cyprus, Smyrna and Turkey successfully propagated in the South made cotton for home use a usual thing in the colonial South. But there was slight commercial development of cotton culture because there was little commercial demand for it.

The first stimulus to southern cotton production was furnished by the Revolution when the cessation of imports compelled the South to grow cotton to furnish its people with clothing. Most of this manufacturing was done in the Piedmont section. Small amounts of raw cotton were sent north into Pennsylvania, Delaware and New Jersey for the same purpose. At the close of the war the demands of Britain for cotton to supply raw material to her new factories kept the South interested in its production. But in 1791 only 4,000 bales (on a 500-pound bale basis) were grown, about 1,000 bales of the Sea Island variety in Georgia and 3,000 bales in the Piedmont region of Georgia and South Carolina.

Then came Whitney's epochal gin in 1793. Immediately the production of cotton in the Piedmont sections of Georgia, South Carolina and Virginia increased by thousands of bales to a total in 1801 of 80,000, half of which was in Piedmont South Carolina, a fourth in Piedmont Georgia and the rest in the Piedmont of Virginia (10,000 bales), North Carolina (8,000 bales), and Tennessee (2,000 bales). By 1810 these states, in about the same relative proportions, were producing 160,000 bales. The purchase of Louisiana in 1803 added a new cotton region which, in 1811, produced the same number of bales as had all the United States in 1791.

It is important to notice that the bulk of the cotton was grown in the Piedmont section of South Carolina and Georgia and that the Piedmont area of Virginia planted in cotton exceeded North Carolina. The Piedmont region of Georgia hardly had been

settled before the Revolution and Piedmont South Carolina had been more thinly populated than the corresponding country directly north. Therefore, the new commodity in South Carolina and Georgia caused less dislocation of established farm practices, and the slave labor system, which accompanied cotton production, competed with fewer free small-scale farmers. North Carolina had the smallest capitalistic planter class on the Plain and hence its Piedmont was less invaded by them for cotton production. Moreover, the small farmers of North Carolina, until 1825, were opposed to the slave system and would not introduce it themselves for the purpose of growing cotton. Using their own free labor they could not compete with the slave cotton system. Instead, they clung to their older habits and this was more or less true of the same class in Piedmont South Carolina and Virginia. Indeed, so far from following other southerners, the Piedmontese more closely emulated the northern economic development, particularly in the promulgation of manufacturing. In this they were successful to such an extent that when the 1810 census was taken there was actually more manufacturing in the South than in New England. According to Tench Coxe, the value of domestic textiles manufactured in North Carolina in 1810 was \$2,289,140 as against \$2,219,279 in Massachusetts.

In 1770 a South Carolina committee had been formed to promote manufacturing in that colony, a movement closely analogous to that started in Philadelphia, New York and Boston. In 1795 a South Carolinian, named William McClure, had started a lottery, the proceeds of which were to establish factories for the manufacture of "Manchester wares." And in 1790 a plantation mill with English machinery is believed to have been erected at Stateburg. If the date and facts about Arkwright machinery are correct—about which there is doubt—then this enterprise shares with Slater's the inauguration of cotton manufacture in America. It is well within the bounds of truth to say that if the South had been released from the shackles of slavery she would have developed manufacturing contemporaneously with New England, for she was well started in that direction in 1810. But after that date slave-grown raw cotton engulfed the South.

The Spread of Cotton Culture.—Between 1810 and 1821 most of the best cotton lands in South Carolina and Georgia had been taken by planters and the emigration of masters with slaves to Alabama, Mississippi and Louisiana had begun, although some of the territory was still held by Indians. Likewise, the Alleghenies were crossed and cotton planting was vigorously promoted in central Tennessee. The production in the Southwest advanced so rapidly that by 1833 the crop there exceeded the output of Georgia and South Carolina, although these states led in number of bales. In 1839 Mississippi passed Georgia, and Louisiana and Alabama exceeded South Carolina. This was possible because the Choctaws were removed from Mississippi in 1830 and the Creeks and Cherokees from Georgia and Alabama in 1836, cotton planters taking the land formerly occupied by the Indians. Another ten years saw Texas added to the column of cotton producers while, at the same time, the Black Belt—black prairie soil plus black people—of northern Alabama and Mississippi began to assert its preëminence in cotton yields. In the decade before 1859 cotton production doubled, the Black Belt and the rich bottom lands of the Mississippi contributing the largest increase. It was in this decade that North Carolina for the first time began to make rapid strides in cotton production in her Piedmont. The 1859 crop marked the climax of cotton yield until 1879, but the location of the Cotton Belt was clearly indicated by the development before the Civil War.

The Effect of the Spread.—The sweep of cotton culture across the South revived moribund slavery and erected the system into a principle hotly defended by southerners. Cotton gave employment to the whole slave family, men, women and pickaninnies. The importation of Africans was stopped by the prohibition of the slave traffic by Parliament in 1807 and by a provision of the American constitution. The increased demand for slaves, therefore, enhanced the value of those secured before the traffic was abolished. It also led to slave-breeding as a business in Maryland and Virginia and started a small amount of slave “bootlegging” from Africa which continued until the Civil War. Cheap land and high priced slaves caused cotton growing to be extensive

rather than intensive, the effort being to produce the most per slave, not the most per acre, an index that was not changed until the fifties, when acre yields were studied as a reflex of high priced cotton.

The bottle neck in cotton production was picking; from the largest planter to the lowliest white struggling to make a crop on the thin soils of the Sand Hills, the area planted was limited by the labor available for picking. In 1800 the normal day's picking was considered 50 pounds. At that rate, there would have been too few slaves to warrant the crop areas of later decades, but either the slave families increased their capacity as pickers or the overseers drove them harder for by 1840, the amount required per field hand was 150 to 200 pounds. The 1800 planting was four acres per slave but in 1840 the area was eight to ten acres per slave. The planters on the Lower Coastal Plain shifted their slaves from rice and indigo to cotton, while the Piedmont tobacco growers abandoned that crop for cotton because the slaves yielded larger revenues per capita when engaged with cotton than with the other crop.

The onrush of cotton obscured every other southern interest. It furnished the income for the South; everything else was subsidiary. Those Piedmontese who would not or could not turn to cotton production were in sad plight. Some, the more energetic or the most wretched, migrated westward. A few went into the new cotton areas of the Mississippi Valley, but most travelled northward across Tennessee and Kentucky to Ohio, Indiana and Illinois. The southern portions of Indiana and Illinois were first settled by migrants from the Piedmont. The modern Hoosier owes much of his unique character to the mingling of the Piedmont stock with that from the Northeast. The typical Hoosier is more of a southerner than a Yankee.

North Carolina furnished the bulk of the migrants, for only a portion of the Piedmont of this state was adapted to cotton culture and its Scotch-Irish population was most opposed to the slavery that was corollary to cotton culture. The North Carolinian whites on small farms were squeezed by the large slave plantations of Virginia and South Carolina. As one of them later said, "they were a valley of humiliation between two mountains of conceit."

The whites who remained in the Piedmont and conducted small-scale farming were forced off the best land which was preempted by slave-owning planters. The individual white farmers were driven eastward to the poorer soils in the Sand Hill area of the Upper Coastal Plain bordering the Fall Line, or westward toward the foothills of the Blue Ridge. They also occupied the low grade soil areas that were mingled with the good cotton soils in the Piedmont cotton section.

Some ineffectually struggled to compete with slave labor in the production of cotton. Owning or occupying the poorer soil, their crop yields were smaller per acre than the plantations. Their crops were as low as 100 pounds of lint per acre, whereas the best plantations got 400 pounds. Having to clothe, feed and shelter themselves on this small yield, they were actually worse off than most of the slaves. However, cotton is a crop that requires only 150 days' labor per year; hence, other supply crops may be produced along with cotton. So, everywhere through the South, on the great plantation, as well as on the one-family white farm, corn—the acreage of which often was equal to that for cotton—oats, wheat, rye, cow peas, sweet and Irish potatoes, sorghum, garden vegetables and fruits were grown. Where cotton was most predominant it never occupied more than 75% of the arable land and usually not much more than half. On the plantations this diversification was a result of the manager's desire to keep slaves employed, while the small-scale farmer was forced to grow these crops to eke out subsistence. We must not infer, however, that the South was self-sustaining by reason of this diversification; cotton was so much the source of income that the South was economically lopsided. The diversification was only a small, partial offset to the lack of balance; it more nearly equilibrated in the case of the small farms operated by white owners.

The whites who had the least ability to combat conditions created by the spread of the "three days' rose" were pushed into the backlands and there they stagnated, living at a subsistence level for generations.

All the foregoing, seemingly an agricultural rather than an industrial discussion, is of first-rate importance because it was the

small white farmer class that comprised the labor supply for southern cotton factories when these came into the South.

Industrial Prophets.—Despite the South's preoccupation with cotton culture, industrial pursuits never were entirely lost. Among the white farmers and especially those that were lowliest, household manufacture was continued generally until 1850; for that matter, it is no rarity even to the present day. When these people entered factories textile manipulation was much less strange to them than to many of the immigrants who flooded the New England mills.

The spokesmen for the South who are best known were men like John C. Calhoun of South Carolina, whose 68 years (1782-1850) almost exactly covered the period of cotton culture under slavery. The talents and voices of these men were devoted to the defense of slavery as a principle. Yet there were other men in the South who by precept and example beseeched their brethren to balance the South's economic structure by adding cotton manufacture to cotton culture. These industrial prophets gained scant attention from Dixie's political leaders, for the prophets' program was inconsistent with the principle for which Calhoun, Nathaniel Macon, Langdon Cheves, and James Orr valiantly contended. A factory system was inherently opposed to slavery. Northern editors and scribes joined the southern prophets in urging the South to adopt industrialism but, naturally, this advice was thought by the southerners to be disingenuous; the northerners were grinding an ax to behead slavery.

Among the industrial prophets were Francis Fries, Michael Schenck, John W. Leak, General McDuffie, Colonel Joel Battle, E. M. Holt, William Bates, John M. Morehead and William Gregg. Francis Fries was the son of a Moravian minister at Salem, North Carolina, and was himself educated for the pulpit but abandoned it for the law court. Becoming agent for the Moravian cotton mill at Salem, Fries learned the advantages of the South in manufacturing and saw the benefit that might accrue. He, therefore, supplemented an active and useful political life with promotion of cotton and woolen factories. Schenck, Leak, McDuffie, Battle and Holt all were farmers who established cotton

mills for their personal profit but with the idea that industrial enterprises were beneficial to the South. Several of these men were personal friends and encouraged each other in their factory experiments. The Holt family later became leaders in cotton manufacturing in the South. William Bates was a migrant to South Carolina from New England in 1816. He founded Batesville, South Carolina, in the pattern of a Yankee mill village. His factory had a long record of success and his son-in-law, Henry P. Hammett, became one of the industrial leaders of the South after the Civil War. John M. Morehead was a lawyer, a politician and a promoter, interested in railroads as well as cotton mills. The industrial experiments of the men mentioned extended from 1816 to the fifties but were most concentrated in the late thirties and early forties.

Of all the leaders, William Gregg perhaps best deserves the title of prophet. He published, in 1845, in the *Charleston Courier* a series of essays on "Domestic Industry," in which with clear logic he pointed out why the South should and could manufacture cotton as well as grow it. He also foretold the results if the South persisted in blinding herself to everything but a passionate defense of slavery. Reading this pamphlet today one is impressed with the man's remarkable prescience. To his writings Gregg added speeches and sought political office in order to put his ideas into practice. But his contemporaries, if they did not completely ignore his advice, scorned his lukewarm attitude toward slavery. Gregg then took his own prescription. He started, in 1847, a cotton factory at Graniteville, South Carolina, his being the first corporation in the state. This mill was a success from the start, and grew with the years until it was the largest ante-bellum factory in the South, having 10,000 spindles at the time of the Civil War. Today, the county in which it was started ranks within the first ten cotton spinning counties of South Carolina and among the first fifty counties in spinning in the United States.

Ante-Bellum Mills.—The Graniteville success, however, was exceptional in southern cotton manufacturing enterprises before the Civil War. Only one other southern mill had 10,000 spindles which in 1860 for the country as a whole was only a fair size.

Most southern mills were equipped with 1,000 spindles or less, and from 1840 to 1860 there was never at any one time more than a score of factories all told. These produced a low grade of yarn almost exclusively and, for the most part, sought only a local market, perhaps in an area of fifty miles around the mill. Moreover, instead of standard size or quality of yarn the factories tried to make all the varieties of the low qualities that the neighborhood wanted. The yarn was bartered and itself at times was used for currency. All of the mills were in the Piedmont and operated by water power. The sites were generally off the beaten tracks of travel and, accordingly, suffered from poor transportation facilities, the horse-drawn wagon constituting the sole service available.

The pre-war mills are interesting as evidence that the South was not totally unaware of her industrial opportunities and that, given relief from the obsession of slavery, her natural development of manufacturing would occur. Actually, however, the pre-war mills had slight influence upon post-war industrial expansion. They were not the acorns that grew into mighty oaks. Batesville may have been the inspiration for some of the later factories in Greenville and Spartansburg Counties, South Carolina—now the leaders in cotton spindles in that state—just as Graniteville undoubtedly was an object lesson for Aiken County, in the same state. But, for the most part, the ante-bellum cotton factories were hermit enterprises and had no progeny.

The Civil War.—The war between the states swept over the cotton fields as destructively as fire. Where military operations did not prohibit cotton growing, the lack of opportunity to export cotton and the necessity to turn all available land and labor into the production of food crops decimated cotton acreage. The few cotton mills existent were pushed to the limit in output but fell so woefully short of the South's needs that household industry was revived on a scale comparable to that of the Revolutionary period. Toward the end of the conflict the few mills were made fewer by the torches and powder of Sherman's "hell."

The bitter experiences of the war taught the South how one-sided her economic structure was. The hunger and rags, not only of civilians, but of soldiers in the field, were conclusive evidence

that dependence on outside sources for food and clothing was fatal. The South had espoused free trade, and certainly no American section had more intensively practiced that tenet of free trade which preaches the specialization of product where it can be produced most cheaply and its exchange for other commodities grown or made where they can be furnished most advantageously. But for free trade to succeed, peace is indispensable. War, or rumors of war, are calamitous to regions that have but one resource. This lesson was twisted into the South by Union bayonets.

Reconstruction.—Appomattox did not end the South's miseries. "Reconstruction" was a gangrene that mortified in the septic wounds left in the South by the Civil War. Despite the high price of cotton—around 20 cents a pound—at the close of the war, planting on the pre-war scale could not immediately begin. Much of the South's managerial ability was beneath the sod, and a great deal of capital had been belched from guns. The labor problem was particularly intense. The negroes used their new freedom in many instances to migrate from the country to the city, from one section to another, and to the North. There was a sudden release for the confined restlessness of generations.

Most of the negroes, however, remained at or near their old homes. They needed employment, knew just one job, and the high price of cotton was an incentive to hire them for cotton field hands. But the application of the wage system signally failed. Finally, land in an amount as large as he would cultivate was rented to the freedman for a definite amount of cotton or a share of the crop. While "making the crop" the negro was advanced equipment and supplies. This system made the negro's subsistence depend upon raising cotton and because he lacked foresight, never having needed it as a slave, it generally put him in debt. The latter bound him to a place.

This scheme was bad economically, agriculturally and ethically, but it was the only apparent solution. It had the effect of breaking up many of the large plantations into small farms. This put the farm area upon an equality with those operated by small white workers and brought white men into competition with negroes as renters and croppers. But it took time to make these readjust-

ments. The cotton crop of 1869 was only half that of 1859 in Alabama, Mississippi and Louisiana. The total crop of 1869 was 2.4 million bales, as compared with 4.3 million just before the war. In North Carolina, where white farmers on small areas were the rule before the war, the 1869 crop was about the same as the previous decade. It was not until 1879 that the crop recovered its pre-war volume. Since cotton was the key to southern prosperity, the key had to be repaired before the South could apply the lessons of the war.

The Start of a New Era.—The year 1880 is a convenient and fairly accurate one to mark the birth of the New South. By that year all but two of the southern states had re-established self-government and cotton culture had been reorganized to meet new conditions. Between 1865 and 1880 the financial bar would have been sufficient to prevent mill construction if no other had existed. This was the period of national paper money inflation. In 1860 cotton mills could be built for about \$20 per spindle, but during the greenback era costs rose to \$40 per spindle. The resumption of specie payments by the United States Treasury in 1879 brought cotton mill machinery prices back toward the 1860 level. So the expansion in the South after 1880 was upon a normal, not an inflated price level. The reduction in prices of machinery was a direct incentive to southern factory construction.

The significant feature of the new era after 1880 was the increase in number of cotton factories and cotton spinning spindles in the South. Look at the record of spindles in place by states.

	1880	1892	Per Cent Increase
Virginia	44,340	94,294	112
North Carolina	93,385	337,786	261
South Carolina	82,334	332,784	304
Georgia	198,656	445,452	124
Alabama	49,432	79,234	60
Mississippi	18,568	57,004	207
Tennessee	35,736	97,524	172
New England	8,632,087	10,934,287	26

For this sudden expansion of manufacturing capacity there were several indirect stimuli and many local causes, acting both separately and together. There was no one cause, unless one may

claim that southern men had acquired a new mental outlook when the fog that had dimmed their thinking was blown away by war. For it was southern men using southern capital who inaugurated the new manufacturing.

The Indirect Stimuli.—There were men in the South who had the vision to foresee her capabilities in cotton manufacturing, but who did not themselves build mills. They exerted their influence through the press and so we call their incitement indirect. At the head of the editors who waged a newspaper campaign for cotton factories was F. W. Dawson of the "News and Courier" of Charleston, South Carolina. Dawson was an Englishman who had served on the "Nashville" during the war and was later a Confederate Army captain. His British background gave him the knowledge to appreciate the potentialities of the South in manufacturing. His paper, until his death in 1889, was an example to other southern sheets in presenting continuously to readers the arguments for industrialization and the news of factories started, together with the methods used for getting them going.

The effect of this campaign cannot be measured but the influence of another indirect stimulus is easily marked. This was the Atlanta International Cotton Exposition of 1881. That the exposition resulted in the establishment of cotton factories is ironical, for the original conception of the show came from Edward Atkinson, the head of the New England textile manufacturers' mutual fire insurance companies, with headquarters in Boston. Atkinson addressed the Georgia Senate in 1880 and urged the legislators, and through them their constituents, to plan an exposition wherein the best agricultural methods in producing raw cotton would be set forth and the improved processes of ginning demonstrated. Atkinson's purpose was to teach the southerners by visual instruction to improve the raw material sent to northern mills. The Georgians seized Atkinson's idea with enthusiasm, but broadened the scope of the exposition to include machinery and other engineering features for the manufacture of cotton. It was the *added* part of the exposition which attracted the most interested observers, and 2 million dollars in orders for machinery were booked.

Perhaps it is no exaggeration to say that the enlightenment given the nation by the Centennial Exposition was duplicated for Georgians and Carolinians by the Atlanta Exposition. There was a subsidiary showing at Charleston. Three years later (1884) Raleigh was the seat of the North Carolina Industrial Exhibit, which carried on the enthusiasm engendered at Atlanta. In 1895, New Orleans had an exposition. Smaller fairs were held in other southern communities, all of them broadcasting the seed of industrialization.

Local Causes for Inception of Manufacturing.—In addition to the general indirect movements for manufacturing there were about as many local causes for interest in industry as there were localities. In many instances the leading men invested in cotton factories to furnish employment to white small-scale farmers and their families reduced to desperation by the ravages of war and reconstruction and by the slump in cotton prices after 1873 (21 cents to 9 cents). In these cases the factory was a sociological experiment in the reduction of unemployment. In others, the skill acquired in manufacturing during the war was continued and augmented in the subsequent peace. Because of the change in plantation management and the adoption of the system of renters and croppers, a number of country merchants became buyers and sellers of cotton, supplementing the functions of factors at port cotton markets. These merchant cotton dealers often quite naturally turned to manufacturing some of the material they handled. Confederate Army officers, defeated finally in battle, and then outvoted in national politics—the South supporting the loser in the Hayes-Tilden contest (1876) and the Garfield-Hancock campaign (1880)—turned their energies from military and political combats to industrial revival as a means of rescuing the South from its post-war plight. These ex-officers, wielding a great public authority, were as courageous in facing the unknown hazards of manufacturing as they had been in advancing against Union cannon. Local leaders of all trades and professions—bankers, farmers, lawyers, merchants, doctors, teachers, mayors, preachers, and sheriffs—looked upon cotton manufacturing as manna to revive

the South. These leaders had two things in common, a great passion to restore their homeland, and a complete ignorance of the technology of manufacturing. Finally, some towns turned to cotton mills in sheer imitation of their neighbors; Spartanburg, Greenville and Anderson furnished the example for the smaller near-by communities.

The motive of private gain was not absent from the southern mill promotions, but it was outweighed by the desire to further public welfare. Mills seemed to be the easiest, quickest road to community prosperity, of which there was pressing need. It is a bit difficult now to realize how widespread the mill campaign was and how much sociological, even spiritual, incentives obscured the usual economic impulses for engaging in manufactures. To be sure, the social and spiritual goals never would have been hit if the economic results had not been satisfactory. The erection of factories in the South was looked upon as a kind of southern patriotism. We must not forget, too, that the terrible refining process of war had burned out much individualistic dross and exalted the cooperative spirit.

Financing the Mills.—If the South was prostrated by the Civil War it is fair to ask how it was able so soon afterwards to pay for scores of new cotton factories. The first mills were for spinning, not weaving, and were relatively small in scale. That is, the usual village enterprise involved investments ranging from \$50,000 to \$100,000. Poor as the South was, it was not without men who could afford to hazard a thousand dollars or more apiece in a new enterprise. In communities too small to have 25 to 50 men in moderate circumstances, machinery was paid for in mill securities. That is, the northern manufacturers of machinery consented to take their pay not in cash but in stock certificates. Commission men in Baltimore, Philadelphia, and New York also subscribed to stock and, in some cases, wholesalers in other lines, such as groceries, saw that their own future business could be increased by buying stock and thus aiding southern towns to erect mills. The cotton yarn commission men also permitted southern mills to make immediate drafts for 80% or more of the value of yarns shipped to commission houses for sale. This enabled south-

ern manufacturers to turn over their capital rapidly, which is the same thing as making a small capital do a large amount of work; this, in turn, reduced the necessary original investment.

In the smallest or poorest communities an ingenious adaptation of the building and loan principle was sometimes used to raise capital. The idea, said to have been suggested by D. A. Tomkins, was to sell mill stock upon installment payments ranging from 25 cents to \$2 a week for four years. With the amount paid in the first year a building was erected or bought; the second year's installments went for the purchase of machinery, while the third and fourth years' investment was available for working capital or plant betterments. Thus, a poor village in three years could acquire a \$100,000 factory. Operatives occasionally were installment investors in the plants that gave them employment, another fact worth the notice of those who think that employe stock ownership is a brand new scheme.

Labor.—There was no problem of labor supply for the first southern mills. As we have said, some of the factories were started purposely to relieve the poverty of many white farming families. In every case, as soon as a mill was opened, families moved to it from the surrounding country. Generally, these people were the descendants of the farmers who had been forced on to the poorer soils when the slave system of cotton culture absorbed the best Piedmont lands. With small farms on inferior soils these dispossessed whites had been sinking lower in poverty for several generations; many of them barely subsisted on the supply crops they raised, augmented by game shot by the men of the family and by wild fruits and berries. Although abjectly poor, these people were not degenerates. Indeed, the back lands of Maine, New Hampshire and Vermont and the sandy pine section of southern New Jersey have furnished far more deplorable examples of retrogression due to isolation and in-breeding than have ever appeared among the Piedmontese. To be sure, the development of the latter had been arrested by their conditions of life, but there was no more perversion than is found in any social order. The high price of cotton after the Civil War had enabled some of them to improve their situation by growing cotton, but

the sharp decline in price after 1872 forced them back to the subsistence level. There were several hundred thousand of these people scattered through the Piedmont, anxious for any opportunity to improve their economic status. This the mills provided.

The labor not being concentrated in any one spot, the factories dotted the whole Piedmont from Virginia to Georgia. Although the Piedmont is rich in water power, the factories were by no means limited in their location to water power sites. By 1880 steam had won its way in cotton manufacturing, and many more southern mills were driven by steam than by water. For fuel, both wood and coal were used, the choice depending upon the location of the mill in reference to transportation and the relative cost of the two fuels. Where available, coal was cheap—around \$3 per ton—but close to the forests wood was still cheaper. The use of steam allowed the factories to spread over the whole Piedmont with small mills drawing upon the local labor supply.

Though abundant in quantity the labor was at first naturally low in quality, for it had no experience in the control of machinery. Some of the labor was familiar with textile operations because of household spinning and weaving, but this acquaintance was not with power-driven machinery. Hence, the southern mills could place fewer spindles or looms in charge of one operative than was the case in contemporary New England factories. The southern laborers not being drilled for factory employment found continuous work irksome, and "laid off" for a day or two whenever the notion seized them. This meant that the mills had to have available more workers than the factory equipment normally required. The relative inferior quality of the labor was offset by its low price. If it is true that wages tend to be set at some point between the cost of subsistence and the income requisite to maintain a standard of living, then both extremes were relatively low in the South. Subsistence was cheap because the weather was mild—clothing and shelter thus were inexpensive—and for the reason that mechanics' home gardens were prolific during a long producing season. Moreover, the streams, forests and brush lots provided much free food throughout most of the year. The standard of living was simple among folks that for generations

had had almost no cash income, little contact with the lures to expenditures found in towns, and had maintained life upon the resources of a small farm. Hence a wage ranging from 50 cents to a dollar a day was munificent.

Type of Product.—Because greater skill was required to operate looms than spinning frames and the management of weaving called for more executive ability, the early southern mills tended to specialize upon spinning. Set in the midst of cotton fields and with untrained labor, the kind of yarn spun was that whose value was imparted by the raw material in it more than by the deftness of labor done upon it.

For these coarse yarns there were excellent markets. Among the best was that of Philadelphia. In that city there were many small-scale weaving establishments that did no spinning for the reason that spinning involved a heavier capital investment and the variety of yarns used was prohibitive of economic production of them. Furthermore, ever since the founding of Germantown, the City of Brotherly Love had been famous for its knitted stockings. This business could be conducted on the basis of one knitting machine. It was generally operated on a small scale. The stocking makers not only bought their yarns, but had their product dyed by specialists. Only the large-scale knitting mills producing a standard stocking did their own spinning and these found often that this operation was no advantage. Between the weavers and the knitters, Philadelphia was an excellent consuming center for yarns.

Those early southern mills that did engage in weaving turned out a cloth without design or pattern, in which the weight of cotton was the principal asset. Osnaburgs, ducks and heavy gray cloths were the varieties favored. The first two had a good market in the South itself, while the third was shipped North for finishing.

Expansion of the Southern Industry.—That the South's sudden spurt in cotton manufacturing between 1880 and 1890 was no temporary ill-founded enterprise was proven by the continued expansion in the decades after 1890. The statistics tell their own story.

ACTIVE COTTON SPINDLES

	1890	Per Cent	1900	Per Cent	1910	Per Cent
United States.	14,384,180	100	19,472,232	100	28,266,862	100
Cotton-growing States	1,570,288	10.9	4,367,688	22.4	10,494,112	37
New England States..	10,934,297	76.1	13,171,377	68	15,735,086	56
All Other States.	1,879,595	13.0	1,933,167	9.6	2,037,664	7
	1920	Per Cent	1925	Per Cent		
United States.	35,480,953	100	35,032,246	100		
Cotton-growing States	15,230,983	43	17,292,042	49.4		
New England States..	18,287,424	52	15,975,442	45.6		
All Other States.	1,962,546	5	1,764,762	5		

While the United States was increasing its number of spindles by $1\frac{1}{2}$ times between 1890 and 1925, the cotton-growing states multiplied their spindles by 11 times. In this period the New England States advanced their spindles by $1\frac{4}{5}$ times up to 1920, but fell back 30% by 1925, so that their net increase was the same as for the United States as a whole. In all other states both the relative percentage and numerical count of spindles declined. In 1890 the South claimed 10% of the spindles of the nation and in 1925 had very close to half the entire number, surpassing all other rivals.

If we studied the amount of cotton consumed by mills according to the same geographic divisions, we should find an even more striking record of southern progress. Beginning in 1890 with a consumption of 538,000 bales, the southern mills attained a consumption of $4\frac{1}{2}$ million bales in 1925. The New England States were using $1\frac{1}{2}$ million bales in 1890 and slightly more than this in 1925, but the latter figure represented a fall from the high point of about $2\frac{1}{2}$ million bales in each year from 1914 to 1920, inclusive. In consumption of cotton the southern mills passed those of the North for the first time in 1905 and have increased their lead since that time. Those to whom New England's cotton industry is dear would assert that an inference of inferiority on account of the relative paucity of cotton consumption is invalid because the finer grades of yarn and cloth manufactured in New England demand less raw cotton than the grades produced in the southern mills; yet these apologists would find it difficult to prove that differences in quality production account for a 200% difference in cotton consumption.

New England's Reaction.—In the eighties, New England cotton manufacturers watched the progress of southern mills, either with indifference or a mild apprehension. In the nineties they awoke to the real threat contained in the southern advance, and in the early years of the new century their dismay became panic at the inroads the South was making on New England leadership. Then the best minds among the Yankee operators began to analyze their situation to see if and wherein they had an advantage and to shape their policies according to their findings.

The South's Advantages—Raw Material.—The South's most obvious favorable situation was the close proximity of mills to cotton fields. Some of them actually operated plantations in connection with the factory property, while many of them had their cotton delivered unbaled direct from nearby gins. Digging into comparative costs one may learn that the price of cotton may be five times as important in relation to profits with mills making coarse goods as with those producing fine yarns and cloth. Therefore, the nearness of the southern mills to raw cotton was a competitive advantage only against northern mills that made yarns of the same low count as those in the South. As the southern mills changed to better qualities, they not only lost some of their relative superiority of location, but since they had to buy selected cotton, they were often unable to get it as advantageously as possible. The charges for cotton shipped from the Mississippi Valley and Texas to the Piedmont were greater than for the same cotton transported to New England, thus reversing the advantage of location.

Buildings.—Inasmuch as the mills in the South were new they had all the benefits of sixty or more years' progress in mill designing and layout, as well as in machinery. Many of the buildings in New England were cramped by their original necessary location alongside a water power site which, being in a valley, was also shut in from winds and the last rays of sunlight. In contrast with these cluttered, stifling, dark mills, the southern plants could choose any place where there was plenty of room for a proper layout, and could perch the buildings on the top of a hill

where the most admirable relations to air and light deliberately could be selected. Since the southern seasons are milder than those in the North, the Piedmont mills could be more lightly and hence cheaply constructed and yet save in heating costs as compared with the North. On the other hand, since many of the northern mills were old their cost had been charged off the books by annual depreciation charges, so that in competition they had to earn less interest on investment, and hence could count that a smaller cost in the prices of goods sold.

Machinery.—What was true of buildings applied also to machinery. In 1880 when some of the inexperienced promoters of southern mills began they bought used machinery from northern mills—those that quickest visualized what southern competition meant and so discarded the machinery for making coarse yarns and cloth. But the southerners soon saw the error in bargain equipment and, in practically every mill, the very latest improved machinery was installed. To make coarse goods with untrained labor the machinery had to be the best obtainable. Since the South is still in the development stage, her mills, as a rule, are much better equipped than the ordinary New England mill, some of which have machines thirty or more years old. In such cases, however, the New Englander's machines usually have already earned their cost, so that this item may be scaled in the costs of production.

Power.—In the matter of power, the advantage of the South is not clear cut, although it is generally asserted that she has a superiority. Until hydroelectric power was introduced after 1900, the South depended more upon steam than upon water. Coal cost at the southern mill about \$3 a ton and the equivalent amount of wood fuel was slightly less. Coal in New England cost from \$1 to \$3 more per ton and wood fuel was not available. When electric transmission and individual motors were applied to cotton factories, the South was first to make general use of this type of power, but since the World War the New England mills have been rapidly making the same change. The differences in rates per kilowatt hour are slight between the two sections and if all

factors are accounted, the difference, if any, may favor New England.

Power costs, however, have slight influence upon the total costs of cotton production, for it is a rare instance when the cost of power exceeds 5% of the total production costs. Yet, a variation in power costs may affect profits twice as much in coarse goods as in fine. Hence, if either section must have an advantage in power, it is the South rather than New England.

Taxes.—Another of the indirect costs in which the South has had a benefit over New England was in taxes. The South, as a whole, for years had lower taxes than the North. The mills of the South were in smaller communities than those of New England, which of itself would mean lower taxes. The southern mills were seldom located within the corporate limits of the town or city but on the edge; they thus escaped the higher tax rate of towns. In a few cases, where the mills were inside the line, the community voted changes in the boundary so as to put the mill outside in the lower tax zone. Some southern towns remitted taxes on cotton factories for a period of years. As the South grew industrially, heavier taxes were levied against her cotton factories, but the burden on the mills was never so onerous as in the older, more thickly populated textile cities of the North.

The great increase in public expenditures by local political units that accompanied and followed the World War was unevenly distributed in the two cotton manufacturing centers. Both had to bear larger taxes, but the New England tax ran up faster than the southern. In 1925, the Massachusetts tax on cotton mills was 40% higher than in the Carolinas and 66 $\frac{2}{3}$ % higher than in Alabama and Georgia. The valuation of New England mills by local assessors was above the book value of the property and much exceeded the sale value. One mill, sold in 1926 for 1 million dollars, had a book value of 8 million and was assessed at 9 million. In 1926 and 1927, the New England manufacturers began a vigorous campaign for a reduction of their local assessments and this was given point by the threatened shut-down of certain factories. In Lowell, a mayor was elected on his promise to secure lower mill taxes to offset the closing of the factories. In

Manchester, the Amoskeag by a lawsuit secured lower taxes. The movement spread to other textile cities. It is important to notice that the mill men asked that taxes be reduced from about \$30 per spindle to around \$10 *in order to relieve the mills from southern competition*. This argument was partly to tickle the public ear but, in part, it voiced genuine need.

Labor: 1. Quantity.—After their nearness to raw material, the most pronounced advantage of southern mills was in their supply of labor. The quantity of the labor for 15 years after 1880 was so great that promoters seldom considered the labor supply when deciding upon the location of a factory; it could be erected anywhere in the Piedmont and enough labor could be drawn from the farms thereabouts to fill the mill. By 1895 the reservoir began to run dry; here and there a mill was embarrassed by lack of help. Mill agents then went further afield and tapped a new source of labor in the whites who had fled to the mountains when slave-owning cotton planters invaded the Piedmont. From 1895 onward mountaineers mingled with the Piedmontese in the factories, but never in numbers equalling the local farmers.

Influence of Cotton Prices on Quantity of Labor.—The quantity of labor has varied with the price of raw cotton. From 1890, when cotton was 11 cents a pound, the price steadily dropped until 1899, when it was 6 cents. During these years farmers found it difficult to eke out a living in raising cotton, and were glad of the opportunity for a steady income offered by the factories. Generally, the whole family moved from the land to the mill but sometimes the men stayed to "make cotton" while the girls went to the mill village. Cotton prices turned in 1900 but not appreciably until 1905, when 10.9 cents per pound was reached (it was 12 cents in 1903 but dropped to 8 cents in 1904). From 1905 to 1913 prices swung between 9 and 14 cents. At every rise labor left the mills for farms and at every reverse they came back to the factories. In 1915, cotton began its war climb to 35 cents in 1919, and since that date it has hovered around 22 cents. At these prices cotton culture was more attractive to many Piedmontese than cotton mill employment.

The high price of cotton was due not only to the World War but to the ravages of the boll weevil and successive seasons of bad weather. The weevil entered southwestern Texas from Mexico in 1892 and each year increased the area of its destructiveness until, in 1922, practically the whole cotton belt was scourged by this pest. While adverse weather cannot be controlled, the enormous losses due to the boll weevil have been partly offset by more intensive cultivation and prodigal use of fertilizer to produce greater crops per acre. These offsets required more field labor, which joined with the price of raw cotton to draw people from the factories. Another agricultural labor factor was the migration of negroes northward during the World War and after the immigration laws were passed. The vacancies in colored farm labor were filled by white labor, some of it taken from the mills. So, while factory spindles have been increasing, labor has been decreasing in quantity.

Competitive Demands for Labor.—Aside from the fluctuation in the labor supply due to influences in cotton culture, the southern cotton factories have faced competitive demands for labor. The mills of 1880 began an industrial revolution in the South. Lumber, fertilizer, and iron manufacture have grown along with cotton manufacturing and have drawn upon the labor available for the cotton mills. In 1925 less than 10% of the aggregate value of southern manufactures was in textile products, indicating that great as has been the development of the cotton industry, general manufacturing has taken longer strides. Moreover, the mill villages, those dominated by cotton as well as those whose manufacturing activity had no relation to cotton, have had a reflex action on near-by farms by creating a market for vegetables, fruits, berries, milk and butter. Before the mills appeared these commodities were produced only for household supply, but the factory village market made them commercial products. Since this improved the profitableness of farming, it had a tendency to restrain migration from the farm land to the mill and so was a factor in mill labor supply.

Colored Labor in Cotton Mills.—The labor quantity in recent years has been approaching a critical point for southern mills and

foreshadows acute shortage. This brings up the question of hiring colored labor for factory work. Up to date, negroes have been employed in yard duties and in the first operations of preparing raw cotton for manufacture, but they have not been used in spinning or weaving. It has been said by people who ought to know, that negroes are unfitted for cotton factories because the work is too confining, too monotonous and requires more deft manipulation than negroes possess. This is a rationalization that fails to stand after careful investigation.

Historically, the whites were taken into cotton mills because so many of them needed this employment, and negroes were kept in cotton fields because that was their traditional place, and also because they were easier to exploit there than whites. The whites being in the mills, the negroes were debarred, not for technological reasons but for social ones. White men and negroes work together in the South without adverse comment; they do this in the skilled hand trades and in the cotton gins, oil mills and steel works. White women and negresses also work together in laundries and canneries. But the southern white man balks at employing white women and black men side by side. This is the real bar to the introduction of colored help into cotton factories. Moreover, to be blunt, colored people working in the confined humid atmosphere of a cotton mill have strong bodily odors offensive to the white olfactory nerve. It is not so well known but equally true that under the same conditions the negro finds the odor of whites disagreeable. Such things, although hushed, count in labor problems.

Under slavery several cotton mills were run with negro labor, and no difficulty was experienced in their deftness. Of late years, also, one or two cotton mills have been operated with full complement of negro help. The fingers nimble enough to pick cotton are sufficiently deft for handling yarn.

It may be that when the labor shortage becomes pressing southern mill operators will have to turn to colored employes. Perhaps a division will be made. The mills producing coarse yarn and cloth may employ negroes exclusively, and the factories specializing on finer products continue to depend entirely on whites.

That the quantity of labor available for cotton manufacture in

the south has been significant in changing the localization of the cotton manufacturing industry is indicated by statistics published in 1928 by the National Bureau of Economic Research. According to this authority, the South, in 1904, had 40% of all wage earners employed in American cotton mills. By 1914 the percentage had risen to 43.1. In 1923 the South employed 50.7% of the total and in 1925 was credited with 55.8%.

Labor: 2. Wages.—The few mills that existed in the South in the sixties paid about 40 cents a day in wages. Some of this wage the mills got back again by operating company stores, the company village being but an extension of the company store idea. Although by paying in goods or credits the early mills conserved money, the plan has in it such possibilities of unfair exploitation that it is condemned.

In the seventies, when the first mills of the new era were beginning, the usual wage was 50 to 60 cents a day. After the boom started in the eighties, the upper limit of wages was pushed to \$1 a day. These low wages were supplemented in company villages by free use of company land for grazing livestock, gardens, and the collection of firewood. During the nineties, as more and more factories were erected, wages continued to advance until \$2 a day was reached. After 1914, when the southern labor situation began to show marked quantitative change, the wages rose above \$2 a day, with an average weekly wage in 1922 of \$15.50.

During all this period after 1880 the wage of the southern mill employe was below that of the New England factory help and, in 1922, the differential was about \$3 per week.

The National Bureau of Economic Research announced in 1928 that it estimated the hourly rates for men in 1914 were 44% higher in the North than in the South, while the difference was 50% in 1926. Likewise, northern women enjoyed hourly rates that were 47% higher than those paid southern women in 1914, and 60% higher in the North than in the South in 1926.

The money wages paid to workers are not the measures of labor cost. That is, low wages do not mean necessarily low labor costs; conversely, low costs can be attained with high wages. The most accurate measure of labor efficiency is the number of

active spindles per worker. Using this standard it is found that the New England cotton spinners supervise about 20% more spindles per operative than those of the South. The superiority of northern labor is an offset to the higher wage. While no reliable data exist for comparing the two sections as to the looms per worker, it is a common observation that wherever the same kind of automatic loom is used in both areas the northern weaver attends more looms than his southern fellow craftsman. The greater productivity of the northern weaver warrants a higher wage. It must be recognized, however, that a difference in labor cost affects profits twice as much in fine goods manufacture as in coarse, so that the northern mills have a greater incentive to promote high labor efficiency.

The southern operatives have not made any concerted effort to raise wages by union activities. It has been difficult to organize the mill help because they spring from individualistic stock. Local grievances do not accumulate for the reason that the help move from mill to mill throughout the whole South. The employes and mill executives spring from the same groups and understand each other; since most of the factories are relatively small, or, if large, are located in small towns, the understanding between management and men has opportunity to ripen. Until recently the quantity of labor exceeded the demand, a condition which smothered incipient unionism. Moreover, the union organizers generally were northern or foreign men and so, as aliens, aroused the opposition rather than support of the southern worker. The latter was both "100% American" and "100% Dixian."

If the southern mill workers do organize unions now that help is becoming scarce they will have a marked advantage in strikes both over their employers and their fellow workers in the North. The southern employes are not far removed from their independent self-subsistence, so that in a strike the workers could outwait their employers by living on the bounty of nature. As the northern textile unions are training southern enthusiasts as organizers, there may be soon an active union movement in the South. The southern union policies will be dictated by northern officers and one of their first efforts will be to bring the southern wage rate up to that in the North. Strikes for this purpose may be more

easily won in the South because climate and starvation cannot be enlisted on the side of the employer.

Labor: 3. Hours.—Inasmuch as the South was agricultural under a slave regime until after the Civil War, legislation fixing the hours of labor was non-existent at the time when first 10 hours and then 9 were becoming the authorized limits for women in industrial pursuits in the northern states. Just as legislation in England and later in New England lagged many years behind the introduction of cotton factories, so it is with the South. Of the cotton-growing as well as manufacturing states, one, Alabama, to this day has placed no legal restriction upon the hours which a woman may work in factories. Of the others, North Carolina and Georgia have a 60-hour week, which is longer than any New England State allows, while Mississippi has established 55 hours, the same as Connecticut, and South Carolina and Tennessee have a 54-hour week, which is identical with New Hampshire and Maine.

These figures, however, do not tell the whole story for they deal with nominal hours. The hours that are worked per wage earner range from 4 to 9 more in the South than in the North. The full time hours per week was in 1914 nearly 10% longer in southern mills than in northern, and in 1926 was nearly 11% longer. This is due, first, to the fact that while the cotton states limit the hours per week they do not prohibit night work. Many of the mills in the South have run 24 hours ever since 1880; this does not mean that the same mill has operated continuously, but different mills at various times have had night shifts, and some mill or other has used that plan every year. We can get this fact from the statistics of hours per spindle which have ranged from 50 to 75 more per month for the South than for the North. That is, both the nominal hours of labor and the actual hours the workers have been employed have generally been longer in the South than in the North. Because the output of cotton factories, more than is common in other industries, depends upon the hours the machinery runs, the advantage of the South is obvious. The hours the southern mills run go a long way to offset any deficiency in the quality of the labor.

New England's Advantages.—To look at the other side of the picture, we may scan the features wherein the New England mills have been superior to those in the South. New England's advantages, although not so obvious as Carolina's or Georgia's, were sufficient to maintain her leadership in American cotton manufacture until 1925. A long-established industry gave her a labor force, the majority of whom were trained to the work, and unproductive "green help" was always in the distinct minority. This enabled the northern mills to turn out goods of high quality at a low labor cost. The New England mills also had plenty of capital at their disposal, very little of which needed to be diverted into channels outside the direct production of cotton cloth. This available capital enabled the northern factory agents to purchase cotton in the best market and store it against need, and at the same time to take full toll from any discounts allowed for cash payments. Secondary plants, such as dye houses, bleacheries or print works, were plentifully distributed throughout the northern textile centers, offering the cotton mills both a convenience and a saving in freight charges not common in the South. Massachusetts for a long time has led all the other states in these subsidiary enterprises.

Cotton manufacture in New England was concentrated in a few localities, whereas in the South it was scattered. This localization was a benefit to the North because it offered a reservoir of trained labor upon which the mills might draw at will; it enabled mills to buy raw materials cooperatively and to get the lowest freight rates because so much of the commodity was carried between the same points; it favored selling because purchasers were attracted to a recognized center; finally, it promoted the interchange and assimilation of new ideas. While most of the southern mills were built in an area bounded by a circle with a 200-mile diameter and a center at Charlotte, they were quite evenly distributed throughout this circle without any city approaching the degree of localization attained at New Bedford, Fall River or Lowell. This lack of concentration is socially desirable and in many ways economically profitable, but it falls short of the economic advantages just mentioned.

The principal sales channels long ago were carved out by New

England mills, and have not changed materially by the advent of the South. These sales outlets are closer to New England and hence favor that section, but the South offsets this by shading prices.

Humidity.—The large maritime mill towns of the North are in a more favorable climatic environment for cotton manufacture than the inland Piedmont mills of the South. The advantage of a humid atmosphere already has been pointed out.

The New England coast has a humidity of about 75% all the year, the highest monthly average being 80% and the lowest 70%. In the Piedmont there is considerable variation from month to month, the late winter months being extremely dry, and the air is much drier at all times than in New England. The Piedmont has more settled weather and less cloudiness; the number of cyclonic storms is only one-third that of New England. Clouds screen the earth from excessive radiation, thus aiding in maintaining an even humidity. New England with a smaller annual rainfall has a larger number of rainy days than the Piedmont. One geographic authority has claimed that New England's variable weather is one of its chief assets because it acts as a stimulus to all workers. In natural climatic conditions, therefore, New England is better adapted to cotton manufacture than the Piedmont section of the South.

It is true, of course, the South is able to produce the proper degrees of temperature and humidity by artificial means, at some cost, neutralizing New England's climatic superiority, and that all the New England mills have to resort more or less to artificial tempering of the atmosphere. The chief advantage of New England's atmospheric conditions, however, finally sifts down to a benefit to workers. While artificial spraying will modify mill humidity to any desired degree, such spraying is not only an expense but it produces an unnaturally stuffy atmosphere, to which the workers are not accustomed and which exposes them to disease when they go out into the open air where the relative humidity may be quite different. The shock is less in New England because the difference within and outside the factories is less most of the year.

Situation in Woven Goods.—Content, before 1900, to make yarns rather than cloth, the South since that date has added greatly to her cloth production. Likewise, after 1905, the South has not been satisfied with production of coarse goods but has entered the fine goods field and has begun to erect finishing plants. In the output of lawn, nainsook, cambric, and the like, the South, although making only one-third the yardage of New England has doubled her output since 1919, at the time when the North was falling off in production by 25%.

This change is reflected in the statistics of looms. The North always has led in the number of looms, but the installation there has slackened and commenced to recede, whereas the South has increased her looms astonishingly. The difference between the two sections which was 200,000 looms in 1880 was 100,000 in 1924. Since 1880, the North has increased the number of looms by 50%, but the South by $28\frac{1}{2}$ times. Since 1922, the number of northern looms has decreased, but the South never has slackened her rate of installation.

New England's Position.—Requiem has been sung over New England many times but the obsequies never have been successful because the corpse has revived while the dirge was being intoned. Her fisheries have lost place, her overseas commerce has become negligible, her farms were abandoned in competition with the rich soils of the Middle West, and her lumber cut long ago passed its zenith. When each of these mortalities occurred New England's doom was announced. Yet, as compared with 1850, the fisheries are twice as valuable, the income from investments in transportation several times the amount garnered from commerce, the farm products valued at 3 times their former total, and the lumber cut almost 3 times as great in dollars received. At present, New England mourns the departure of shoe manufacturing to St. Louis, machine production to Detroit, and cotton manufacture to Spartanburg. The truth is that once New England enjoyed a lonely position at the pinnacle of industry, whereas now she has plenty of company; first rank has been snatched from her but her absolute production and income have suffered no serious casualty. From the national viewpoint it would have been

economically deplorable if New England had continued to furnish the bulk of the country's manufactured goods.

Yet it cannot be denied that in cotton manufacture New England must revise her industry. She has not yielded coarse goods to the South but she must if she is to survive. As for fine goods, which the South also is now making, there are many grades. Lawn, for example, varies from 15 cents to nearly a dollar a yard, the prices corresponding to differences in quality. In the finest grades of cotton cloth there are not more than half a dozen southern mills out of a total of over 1,000 directly competing with the New England mills that produce these grades. New England should successively relinquish the lower levels of all goods to the South and, herself, constantly seek higher levels. This involves surrender of first place to the South in *number* of mills, of spindles and looms, and in *quantity* of output, and may cause the abandonment of some New England mills—the marginal producers—but the result will be a larger net profit to the surviving Yankee operators. Before 1880 New England bore the same relation to Britain that the South now does to the North; New England might well scan the practices of Great Britain since 1880 and adopt those that fit.

Potential Centers.—The Piedmont cotton factories which have defied New England so successfully are themselves not without challenge. The Cotton Belt began to move southwest as early as 1820 and by 1840 Mississippi led Georgia. In 1859 Georgia was the only south Atlantic state in the first five producers and ranked fourth. Texas moved into first place in 1889 and has never been dislodged. In 1924, the leading raw cotton producers were Texas (36% of the total ginned), Oklahoma (11% of all ginned), Mississippi (8%), Arkansas (8%), and Georgia (7.4%).

All the factors which in 1880 favored the Piedmont manufacturers over New England now apply as between the Southwest and the Piedmont. That they are not overlooked is evidenced by the comparative percentage of growth between the two sections of the South. Between 1919 and 1925 the number of mills increased in Texas 87%, in Tennessee 16%, and Alabama

14%. For North Carolina the addition was 11%; in South Carolina and Georgia the number of new mills was negligible. As for spindles, North Carolina advanced at a higher rate than her Piedmont competitors, but at less than half the rate of Tennessee and one-fourth the rate of Texas. In number of looms, Oklahoma with a small absolute number multiplied them six times, while the rate of advance in Texas and Tennessee was more than twice that of North Carolina. That is, the states in or near the new centers of the cotton producing belt, although their absolute number of factories and machine capacity are small as contrasted with the Piedmont, are, nevertheless, adding to the mills and their capacity at a much more rapid rate.

It appears that we are setting up three distinct cotton mill centers: the Southwest, making the coarse yarns and goods; the Piedmont, entering the manufacture of medium grades; and New England, producing the finest. If the trend southwest is maintained the city of St. Louis sometime may awake to her potentialities in cotton manufacture. At present, there is none of any amount there but the city is one of the chief distributing points for cotton goods, is close to coal, on the edge of the Cotton Belt, and not only has labor in the municipality but an untouched supply in the Ozarks.

The West.—After the opening of the irrigation projects in Salt River, Arizona, and the Imperial Valley, California, considerable attention was given to growing long staple cotton of the Egyptian type, the crop ranging from 375 bales in 1912 to 20,000 bales in 1925, which was 1/145th of the crop in Egypt. Much of the American western crop was taken by tire manufacturers and one company erected cotton and tire factories in California. However important this production and manufacture are locally, they have the smallest national significance.

Instability.—Whether in the South or North, cotton manufacture is fundamentally unstable. The principal vegetable fibers competitive with cotton are flax and ramie. All three of these have limiting factors which determine their relative use. For cotton before 1793 the two matters vital were the labor for picking

and the separation of seed from lint. Flax and ramie have always been narrowed by reason of the expense necessary to separate the fibers from the stalks. As textile fibers, ramie ranks first, followed by flax and cotton. Before Whitney's gin the retting of flax was less expensive than the combined costs of picking and cleaning cotton, and, in consequence, linen was the cloth favored for common use, cotton being as luxurious as silk. The gin upset this condition and made cotton the cheapest of all the vegetable fibers, usurping most of the uses of flax.

The instability of the business lies in the possibilities of mechanical or chemical discoveries in relation to any one or all three of the fibers. A machine for picking cotton would render cotton unassailable by the other two, while a cheap process for procuring either ramie or flax fibers would at once put cotton on the defensive. Not only would manufacturing standards and equipment be overturned by any one of these three contingencies but agriculture, transportation, commerce and international relations would be altered.

That such chances are not visionary is illustrated by the forces set in motion by the recent exploitation of rayon.

Rayon.—Rayon is a trade name to denote artificial silk. The chemistry of silk was discovered in 1710, but no one produced artificial silk until 1884, when Count de Chardonnet made it from wood pulp obtained from mulberry trees. Still later, it was learned that the cellulose which was the chemical base for silk was obtainable from wood pulp, cotton linters and other vegetable products. Moreover, these various materials could be treated in different ways to gain the desired results. Since 1900 more than 2,000 patents have been issued for the manufacture of artificial silk.

When this product was put upon the market after 1900 it was called "artificial silk," or "silk substitute." The public is opposed to substitutes, however, so that the new material had only a narrow market for braids, trimmings, fringes and novelties. This product, too, at that time, could not withstand the laundry. But new methods of production yielding a strong, water resistant yarn, together with an amazing advance in the

public's use of real silk, put this new cheaper fiber in an excellent competitive position. Then it was discovered that rayon combined readily with silk, wool and cotton, and since it reacted to dyes differently than any of these, opened a field for textile designs and colors hitherto unknown. To overcome prejudice against a "substitute" and to enable the product to stand on its own merits, the textile trade adopted the name "Rayon" after 1920.

The manufacture of rayon yarn is a chemical industry requiring great technical ability and capital far in excess of that common in the textile business and, in addition, is based on patents. Hence, in 1924, there were only a half dozen or so plants in the United States manufacturing rayon yarn. The greatest, by a wide margin, was the Viscose Company, with plants near Philadelphia, at Roanoke, Virginia, and Parkersburg, West Virginia. The Tubize Artificial Silk Company was second in capacity, with a plant at Hopewell, Virginia. The DuPont Rayon Company has a plant at Nashville, Tennessee—a converted war munitions works. There are large rayon mills at Johnson City, Tennessee and at Cumberland, Maryland. So far, rayon yarn manufacture has been a southern industry because it has used cotton linters as a raw material, but with the use of wood pulp the industry will have a northern branch, an interesting reversal of the story of cotton manufacture. In 1913, our national production of rayon was 1½ million pounds, increasing slowly to 8 millions in 1920, but since that date up to 1925 the output has been multiplied by ten. Yet, as the market demand was greatly in excess of the supply, all the producers were adding to capacity and new manufacturers were entering the business.

The largest buyers of rayon yarn have been the cotton manufacturers who mixed rayon with cotton to produce cloth more varied and beautiful than ever before seen. The cotton mills take a little over one-fourth of the rayon manufactured. This new textile fiber has also invaded other fields formerly occupied by cotton, such as the knitted underwear, sweaters, coats, dress goods, combinations of mixtures of wool and rayon. Rayon is selling in twice as many pounds as natural silk and is being woven and knitted with natural silk in many products.

Rayon fiber being a manufactured product suffers no disabili-

ties from weather and pests, like raw cotton, nor from other influences like raw wool and natural silk. The sources of rayon are inexhaustible. Since rayon is a chemical product, and inasmuch as in the rapidity of the growth of the industry since 1920 chemists have confined their attention to one type of yarn, we have but barely started the utilization of rayon. Chemically, it is as possible for it to approach cotton or wool in its qualities, as it has already for natural silk. In short, to the three giant textile fibers, COTTON WOOL, and SILK, we have added a fourth, RAYON. So far, rayon has supplemented the other three, but it is capable of so many attributes that it may supplant the older fibers in their own fields and proceed to new fields now undreamed. This is just one illustration of the fundamental instability of textile manufactures. Cotton manufacture, a billion-dollar industry, is built upon sand, a shifting foundation subject to the winds of chance.

CHAPTER XVI

WOOL

Wool versus Cotton.—Although wool and cotton have many similar uses and are now manufactured by analogous processes, the history of the two textiles has had little in common. Cotton for ages was a luxury, like silk, and never was manufactured in large amounts in households. Cotton cloth, as a staple for the masses, was a resultant of the Industrial Revolution. Cotton manufacture is a modern machine industry. Wool, on the other hand, has been used for the comfort of man for so many centuries that no one knows how long ago wool manufacture started. It was one of the incentives to the evolution of civilization, and the textile arts connected with the manipulation of wool were known all the way round the world, from China in the east to Peru in the west. From the age of myths to the era of radios, from “icy mountains” to “coral strands,” wool manufacture has accompanied the story and wanderings of mankind.

Sheep in Antiquity.—It is supposed that Man originated in Central Asia and it is fairly authenticated that sheep spread from the same source. Some hold that sheep were the first animals domesticated by man and migrated with man from the original home of both, each being modified by the new environments they found. The earliest documented records of sheep placed them in Persia and the Tigris-Euphrates valleys. Later, it is certain that flocks and herds constituted the wealth of Arabia and their importance in Palestine is established by the direct references to them in the Bible, as well as by the figurative language of that book. Egypt shunned sheep and legislated against them, but the Egyptians used wool in their arts. The rest of northern Africa followed pastoral occupations just as commonly as the Arabians, and it was from Africa that sheep raising and wool utilization were introduced into Europe.

The Greeks were the first European shepherds and Arcadia not only became the symbol for all pastoral beauty but furnished the mythological worship of Pan, the musical god of shepherds. Among the many useful and cultural things the Romans learned from the Greeks were the principles of flock control and the processing of wool. Faun was the Roman Pan, just as Daphnis was the Pan of Sicily, in both cases the fable and worship being introduced by Arcadian shepherds who brought flocks into Italy. The Romans gathered many wool workers together under one roof, producing yarn and cloth quantitatively—the germ of a “factory system.” Later on, the Romans taught the rude Gauls what the Greeks had inculcated, thus carrying Arabian animals and arts to Flanders and Briton. Spain was doubly instructed, both by the Romans and the Moors, and so improved upon her masters that Spanish sheep and wool textiles became the highest prized in the world.

The Europeans who settled America brought sheep with them. As the continent was explored and settled, sheep nibbled their way with the pioneers across the mountains, prairies, plains and deserts until the Pacific was reached. Curiously, no two places on the earth’s surface are more nearly alike in climate and products than Palestine and California, so that when merino sheep were raised in large numbers in California the Arabian fleece-bearing animal really reached home again after 2,000 years of westward migration.

Ancient Wool Manufacture.—Doubtless the pelts of sheep were used by the ancients before the fleece was manufactured into garments. It seems probable, too, that the felting qualities of wool were discovered before the arts of spinning and weaving were known. Felt was used as armor against arrows, darts, and slings. For clothing, felt was originally confined to caps and socks. With the Arabians, spinning and weaving were universal and not only furnished wool clothing and bedding but supplied materials for tents and utensils. Carpets were brought to a high stage of art by the Arabians and their neighbors in Asia Minor long before Europeans knew anything about floor coverings, except rushes and sawdust. The Phoenicians specialized in the

manufacture of wool, making it one of the bases of their far flung commerce. They bought raw wool from the Arabians, or from the colony at Carthage, and made it into cloth. They discovered dyeing and their purple dyed cloths fetched a price 40 times that of the plain material.

The Greeks were expert wool manufacturers. They not only supplied themselves by their household industry, but like the Phoenicians whom they supplanted, had a surplus for trading with foreigners. Of all the ancient peoples the Romans carried wool manufacture to the highest point. Their goods were no finer than certain examples of older civilizations, but the bulk of their product was better made, and the volume of output the largest up to their time.

The most apt pupils of the Romans in the manufacture of wool were the Belgae opposite Briton. After the fall of Rome, the Flemish became the best known cloth makers. Flemish goods were imported to England with the Norman conquerors and, from time to time, Flemish artisans emigrated to England. It was Edward III who early in the 14th century, taking advantage of political disturbances in Flanders, entered upon a deliberate policy of inducing Flemish spinners, weavers and dyers to settle in England, the shrewdness of which regal course was soon justified by England's rise as an industrial commercial nation. For five centuries British kings and Parliaments fostered sheep raising and wool manufacture. Knowledge of wool was part of our own heritage from Britain, and when our turn came to enter upon wool manufacture it was British workmen who taught us the "tricks of the trade."

With such a lineage it is no wonder that wool manufacture was crusted with traditional methods and honeycombed with subdivided crafts. Consequently, the industry yielded so slowly to modern machine production that complex large-scale capitalistic manufacture did not become common until after such organization was taken for granted in cotton manufacture.

Colonial Wool Industry.—The London Company sent sheep with the first colonists to Jamestown, and thirteen years after the Pilgrims set foot on Plymouth Rock, sheep were introduced

into Massachusetts. The Dutch West India Company supplied its New Netherlands with sheep, beginning in 1625; and the Swedes who settled on the Delaware were shepherds as well as farmers. In short, sheep were considered an essential in farm economy everywhere in colonial America.

Sheep were an integral part of general farming because, like their kin the goats, they were excellent scavengers, clearing the ground of roots, shrubs, brush and rubbish, while at the same time they added to soil fertility by their excrement. Nearly every colonist used sheep for these purposes.

The meat from the sheep was disregarded; indeed, there was considerable prejudice against native mutton and many people preferred hunger to eating sheep meat. This was because the sheep were scrub varieties, and being given little care were themselves half-starved. Moreover, the colonists had little knowledge of the proper method of preparing mutton for cooking, so that the meat had a rancid taste.

In these circumstances, wool was the sole product from sheep husbandry. It continued as a scavenger's by-product, useful for household manufacture alone, because the British, solicitous for the welfare of their own wool manufacturing, were vigilant in suppressing incipient competition in America. In 1655, Massachusetts required each family to prepare per week three pounds of woollen, cotton or linen yarn. Again, in 1684, Virginia passed a law to encourage wool manufacture. Likewise, legislation was enacted in various colonies giving special privileges and easing taxes on breeders of sheep. Alert to what these provisions might mean to her own cherished wool manufacture, the British annulled the Virginia law, and the royal provincial governors prohibited the manufacture of wool cloth, except to be worn by the family that made it. Wool cloth of domestic manufacture was officially banned in intercolonial or intercommunity commerce. Hence no colonial farmers kept flocks larger than were necessary for clearing brush land and to furnish wool sufficient to clothe the pioneer's own family. Aside from the removal of incentive to large flocks by reason of the British prohibitions on commercial manufacture, the number of sheep would have been small because they were the

most expensive livestock a farmer could exploit. They required more care and protection than hogs, horses or cattle, and yielded less return for the time and attention given to them. So, notwithstanding that sheep were raised in every colony and on well-nigh every farm or plantation, the number was always small, and the wool restricted to household manufacture and use.

Fulling Mills.—The only breach in household self-sufficiency regarding the production of wool cloth was the process called "fulling." Woven wool cloth was harsh and stiff and required further manipulation. This consisted in washing the cloth in warm water and dissolved soap, softening the surface by the inclusion of short wool fibers, beating the cloth with sticks or mallets, and lifting the nap with teasels (a bur or head of a special plant whose flower was covered with hooked modified leaves). These processes called for dexterity, artistry and strength beyond the capabilities of most families, so, together, they became a specialized branch of textile manufacture conducted by experienced men highly skilled in the operations. These artisans were aided by simple machinery operated by man, horse and water power; hence a fuller's establishment was called a mill.

The first fulling mill in America was set up in 1643 by John Pearson, at Rowley, Massachusetts, where a group of Yorkshire Non-Conformists had settled, Yorkshire being the English wool manufacturing center. A second fulling mill appeared in Watertown, Massachusetts, in 1662, where another was added twenty-four years later. Dedham, Massachusetts, claimed the third fulling mill, started in 1681. In Connecticut, the first mill was at New London, in 1693; in New Jersey, Rahway had first honors in 1703. The first mill of Virginia dates from 1692, and Pennsylvania had several by 1700. After that date fulling mills were too numerous and common to warrant special mention, for nearly every sizable community included a fulling mill among its necessities of life. The first fulling mill to utilize water power was one in Byfield, Massachusetts, in 1794. Fulling mills maintained existence separate from other branches of wool manufacture and in considerable numbers as late as 1890. After that most fulling was done in a department of a cloth factory.

Weavers.—An occasional lapse in colonial household self-sufficiency occurred as regards wool weaving. Skill, strength and reach were required in this process: Some families, accordingly, contented themselves with the simpler preparation of yarn and left the weaving to specialists. Weavers were a dusty brotherhood who footed the highways and by-paths from household to household, applying their skill upon yarn the families provided and on looms the home possessed. In larger towns weavers had their own looms in their own house or shed, and wove cloth from yarn furnished by the neighbors. The weavers did not buy yarn or sell cloth but worked on commission. But such specialized weaving was relatively rare.

At the time the first federal census was taken, from two-thirds to three-fourths of all clothing worn in this country was made upon the premises of the people whose backs it draped. The balance was made up by imports from England, France and the Low Countries. People in the cities near the coast and in the South were large purchasers of foreign cloth, but nearly all the rest supplied themselves by their own toil.

Specialized Centers.—As a rule, no individual communities became noted for the production of any wool commodity; to this generality, however, there were a few exceptions. Germantown, in the environs of Philadelphia, early became famous for its knitted woolen stockings and helped to supply all of the colonies with these articles. This industry was centered there because a large number of immigrants from the Palatinate, who founded the village, brought to this country the art and skill acquired in their ancestral homes. To them, and the early start they gave in wool manufacture, Philadelphia owes her present-day eminence in the industry. Likewise certain Englishmen from Yorkshire, long trained in wool manufacture, who settled at Rowley, Massachusetts, made that town unique in the amount and variety of wool products. Irish immigrants from the linen-producing section around Londonderry, after settlement at Londonderry, New Hampshire, made that community distinguished for the manufacture of linen and wool cloth. A small group of Moravians at Bethlehem, Pennsylvania, were likewise renowned for their

wool products. These cases were out of the ordinary, for wool generally was manufactured where it was grown and used.

The Revolutionary War.—The long standing British restriction upon colonial wool manufacturing resulted in privation for civilians and suffering for soldiers during the Revolutionary War. The policy exposed us to dearth of wool and shortage of cloth when hostilities deprived us of customary imports. This situation, in turn, stimulated household production to unprecedented outputs and it was the product of home industry which carried us through the war years. Inasmuch as the household always had made the bulk of the coarse goods, the stoppage of imports was felt chiefly in the lack of the medium and high grades of cloth. Patriotism was evoked to popularize the wearing of rough homespun and home woven materials. Civilians of means, therefore, were injured more in their pride and bodily comfort than in their actual exposure to cold and wet. The poorer people and those in the back country districts who always had worn coarse domestic goods, were more directly injured by the general scarcity and high values of clothing materials. What they made themselves often they could not afford to keep, but turned into the markets. But it was the soldiers who really were distressed by the prevailing scarcity of woolen goods; they had insufficient blankets, stockings and great-coats, and their uniforms—when they had any—were sometimes reduced to rags before they could be replaced. Despite the great increase in household production of yarn and cloth and a patriotic fervor which made knitting, by a new rule of etiquette, a social diversion, there was a shortage of wool and, by consequence, shortage in the supply of clothing materials, so that the population, as a whole, had less to cover their backs and their beds. It was this experience that directed attention to wool manufacture as soon as the Peace of Paris was signed in 1783.

Promotion Societies.—The very next year a society was formed in Boston for the promotion of domestic manufacturing. Philadelphia followed (1787), and so did New York (1788), Wilmington (1789), Baltimore (1789), and Portsmouth (1789).

In these cities buildings were secured where spinners and weavers were gathered together to practice their arts and to teach novices. These efforts really had a double purpose; that of doing a little to sever America from economic bondage to Europe, and to provide employment for those made destitute by the war and its aftermath. None was a true factory, for no power machinery was utilized; they were the American counterparts of the Roman collection of manual craftsmen under one roof, and the British aggregations of hand workers at the apex of the domestic system of production. Both in Rome and in Britain these collocations of workers foreshadowed a true factory system. In America they served to focus notice upon the textile industry and, undoubtedly, made many persons familiar with textile operations; but that they paved the way for factories in any definite manner is doubtful.

The First Wool Factories.—In Britain after the Revolution, when cotton manufacture was forging ahead vigorously, the wool industry but feebly responded to the new conditions. It was not until 1785 that Benjamin Gott fitted a wool factory with a power carder, power spinner and power loom. It was well along in the next century before the British wool factories were able to make decisive inroads upon the traditional wool handicrafts and, even then, the British wool factories were more highly specialized in their productions than was true in the corresponding cotton industry.

Since our mentors were so tardy it is rather remarkable that Americans began almost as soon to adapt wool manufacture to factory methods. Jeremiah Wadsworth of Hartford, Connecticut, in 1788, organized the first American wool mill containing more than a single loom. The following year another mill was started at Stockbridge, Massachusetts, and, in 1790, one was opened at Watertown, Massachusetts. By 1810 there were 24 wool mills in the United States. Of these 5 produced fine cloth and 9 devoted themselves to coarse goods. That these 14 were all small may be seen when it is known that they averaged about 10,000 yards of goods each per year. The remaining 10 mills were still smaller than these and really were but craftsmen's shops, with an added machine or two. In the census of 1810 it was

estimated that the whole 24 mills produced about 200,000 yards of cloth, while the family output of wool cloth for that year was deemed to be $9\frac{1}{2}$ million yards.

The term "factory" as applied to these early wool ventures is a partial misnomer for several purchased yarn from households and did all the weaving in the "factory" on hand looms. A power carding machine was operated in a mill at Byfield, Massachusetts, in 1804, and in the same year, a power spinner was set up at Peace Dale, Rhode Island, but it was 1823 before a wool power loom was installed (at Southbridge), and power machinery, even after the inaugurations mentioned, was rare in American wool manufactures until after 1820; actually hand jennies and looms were common until the Civil War. At the time the first mills were struggling to live, the principal inventions in the wool industry were such devices as portable spinning jennies, improved hand cards, and carding machines, all of them designed to increase the efficiency of household manufacture.

John and Arthur Scholfield.—Just as Samuel Slater circumvented the British law that prohibited the export of mechanical devices and hindered the emigration of skilled artisans, so too, John and Arthur Scholfield of Yorkshire evaded the vigilance of port officers and sailed to America in 1792. Some authorities say they brought with them a part of a power carder, the other part of which went by another vessel with two other mechanics. At the time Slater emigrated the Arkwright cotton machinery was much more developed than the Gott wool machinery was when the Scholfields left England. The latter therefore had less to contribute to America than Slater. Yet the brothers were called upon for advice and personal direction in several of the early wool mills in America. One or both were engaged at Charlestown, Newburyport, Byfield, and Pittsfield in Massachusetts, and Montville, Stonington and Rockville, Connecticut. It was the Scholfields who set up the first power carder, probably at Charlestown, where it was run three years; it was then taken to Byfield for four years' service. Later this identical machine was in use at Newburyport, and at Nashua, Jaffrey and Marlboro, New Hampshire, its active career extending to about 1900 when the machine was

108 years old. Although the Scholfields were doubtless the most influential of the individual British workmen who aided the first American wool mills there were about a score of other Yorkshire artisans whose experience guided our earliest enterprises.

The Merino Craze.—Besides the stimulus to wool manufacture provided by the arrival of skilled British craftsmen another and greater incentive was the importation of merino sheep.

The sheep of America by reason of the vicissitudes of colonial life were not bred with care and so were a scrub lot yielding coarse, short-fibered wool. From this material it was impossible to make the finer grades of cloth to which our post-Revolutionary manufacturers aspired.

The best wool sheep in the world in 1800 were the merino flocks of Spain. It is supposed that the merino breed originated in Rome. The native Italian sheep that yielded the finest wool were indulged animals, kept indoors much of the time and had their fleece washed, combed and oiled just as today some lone-some ladies pamper pet poodles. These sheep, like the best of those in Greece and Arabia, were protected from weather by homemade jackets of skin or leather. The Roman sheep, weakened by their fondling, were crossed with vigorous, yet fine wooled African rams. This resulted in flocks yielding fine wool without excessive attention. These sheep taken to Spain by the Romans were again infused with the blood of African sheep by the Moors. The result was the merino carefully bred for centuries by the Spanish shepherds. So prized was the breed that Spain refused to let any of the live animals, except for a few royal gifts, leave the national boundaries. It was not until Spain was drawn into the maelstrom of Napoleonic conflicts that the Spanish flocks were broken and scattered.

In 1793 William Foster of Massachusetts managed to smuggle three Spanish merinos worth about \$1,500 to a friend in Boston, but the recipient, being unaware of the value of the unexpected gift, slaughtered the sheep and graced the family dining table with the meat. M. Dupont de Nemours of Wilmington, Delaware, imported, in 1801, a famous merino ram named Dom Pedro and valued at \$1,000. In 1802 Robert R. Livingston,

Minister to France, secured two pairs of merinos for his New York manor, while in the same year Colonel David Humphreys, who was then Minister to Spain, sent to Derby, Connecticut, 21 Spanish merino rams and 70 ewes. William Jarvis of Vermont was American Consul at Lisbon, Portugal, when, in 1809-1810, the merino flocks of Spanish nobles were confiscated. Jarvis sent 3,850 of the merinos which he personally selected to different American ports. About 2,500 more merinos were brought to the United States in 1810 by other promoters. As a result of these different importations a craze for breeding sheep with merinos swept the country, the first of several similar frantic scrambles for a particular breed of sheep.

Humphreysville Manufacturing Company.—David Humphreys was born in Derby, Connecticut, in 1752, educated at Yale and served with distinction throughout the Revolution. He was on Washington's staff and received the colors from Cornwallis at Yorktown. President Washington appointed Humphreys as Minister to Lisbon, where he served until 1797, when John Adams sent him to Spain. Returning in 1802 to Derby with his 21 merino rams and 70 ewes, Humphreys sought a location for a mill to manufacture the fine wool of these sheep. At a place called Chusetown, after a local Indian chief, within the township of Derby and at a natural fall of the Naugatuck River, Humphreys bought the power rights and the existing sawmill, two fulling mills and a wool clothier's shop. In order to get the best experience for his proposed mill Humphreys went to England, and after investigating methods there, secured the services of John Winterbotham, a man thoroughly informed in all branches of wool manufacture. Humphreys also persuaded a half dozen skilled workers in wool to accompany Winterbotham across the Atlantic. Returning to Derby, Humphreys associated his neighbor, Captain Thomas Vose, in the enterprise and they built a mill in 1806. With the aid of the British craftsmen the company, called "T. Vose & Company," began producing fine wool cloth. Chusetown was renamed Humphreysville in 1804, and retained the name for 46 years. When the town was incorporated in 1850 the name again was altered to Seymour in honor of the state governor of

that year. The manufacturing company was reorganized in 1810 and the title altered to the "Humphreysville Manufacturing Company." At that time it employed 150 people and was the largest wool cloth establishment in the United States. It continued as an important manufacturer of wool cloth until 1831, when a change in directorate caused a change in policy as a result of which the company shifted from wool manufacture to the production of paper.

Humphreys had the same paternal attitude toward employes as that evidenced by the cotton manufacturers near Pawtucket. He laid out a model cottage colony along the river bank and paid competent teachers to instruct the "help" in evening and Sunday schools. The boys and young men he organized into military companies, trained them himself and supplied uniforms, his wife donating a silk military flag, the work of her hands. In 1813 Humphreys was instrumental in securing a state law which instructed the local selectmen and magistrates to act as factory inspectors, paying particular attention to the physical and moral environment of workers. The efforts of Humphreys attracted as much favorable outside attention among those interested in wool manufacture as the early Lowell proprietors did among cotton manufacturers. Humphreysville was often referred to as the "model wool factory town." Humphreys himself commanded two Connecticut militia companies during the War of 1812 and was commissioned as Brigadier General. He has been most often called by the militia title of General rather than his Revolutionary army ranking of Colonel. He died at New Haven in 1818.

The subsequent history of this Humphreysville Manufacturing Company, so ambitious at its start, is illuminating; for it is typical of dozens of others which have at one time engaged in wool manufacture. The company owned valuable water power rights as well as mill buildings. The power was leased at different times to makers of lumber, paper, cotton cloth, pins, sheet copper, augers and bits, wool yarn, finishers of wool cloth (fullers and clothiers), silk, and mohair plush. As an organization the Humphreysville Manufacturing Company turned to the production of paper for newsprint in 1831 and to augers and bits in 1845, in which it engaged for more than sixty years. Meanwhile,

alongside of the original wool factory at the Falls, the Eagle Silk Manufacturing Company built a brick mill in 1850. After changing hands as a silk producer this factory was devoted to the making of worsted cloth under the name Kalmia Mills and owned by Zurcher Brothers, New York commission merchants. The factory closed in 1869 and was not reopened until 1880, when the Tingle Manufacturing Company bought it for the making of mohair plush, the first of its kind in America and a business which is still conducted at the spot. The actual wool factory of the Humphreysville Company after being converted for a while to a paper mill, later housed a horseshoe nail factory, and still later a part of it was used by a family of machinists to produce machine tools and accessories. The land on which it stood was then purchased with other adjoining parcels, upon which was erected a group of concrete buildings for the manufacture of Waterman Fountain Pens almost exactly a century after Humphreys built his mill with so much hopeful enthusiasm. Glory is brief.

The War of 1812.—The Humphreysville Manufacturing Company and four others were the only wool manufacturers who before 1812 endeavored to produce fine wool broadcloth in competition with that imported from British and French sources. The other wool mills, 20 in number, struggled to turn out a product between the grade of the fine imports and the coarse cloth of the homestead cards, wheels and looms. The War of 1812 shut out imports and by reason of the clamor for wool goods, particularly for the army, navy and negro slaves, encouraged many new enterprises. This growth, though greatest in New England and the Philadelphia regions, was shared by all the states and even the western territories, for small wool mills appeared everywhere.

But this expansion was a war exotic and was blasted by the return of peace. The goods accumulated in Britain during the war were dumped in our market in 1815 and 1816 partly to realize something upon them and partly with the deliberate intention of strangling the war-born American wool mills. In one year the import of foreign woolens mounted to 155 million dollars in value, which was six times the normal value of the output of our own

mills. The British knew that America was their best market and they wished to preserve it for themselves alone. In addition to flooding our goods market British agents were said to have passed through our wool-producing counties purchasing our best wool-producing sheep and sending them to the nearest butcher, thus removing a potential raw material competing with their own. It was claimed also, at the time, that British agents went from one small American factory to another purchasing the best machinery, which was then boxed and shipped to England with the purpose of snuffing competition. The distressed Americans, whether sheep raisers or manufacturers, did not question the motives of anyone who offered cash relief.

The disaster to our incipient wool manufacture was well-nigh complete. The 1820 output was only one-sixth that of 1810 and it was 1840 before the mills again approached the figures of output reached during the war. It was in 1815 that the stricken wool manufacturers first turned to Congress for tariff relief from the plague of foreign cloth, and Congress responded the next year with its first definite imposition of duties to protect domestic industry.

Unstable Recovery.—Wool manufacture began to recuperate in 1820, and after increasingly strong doses of tariff medicine in 1824 and 1828, the patient was fairly convalescent. From then until the Civil War the number of mills and value of output gradually increased. But the industry never enjoyed continuous prosperity; lean years trod upon fat ones. Mills were constructed only to be closed or changed to other products. Those that continued to manufacture wool did so under constantly changing ownership. All the mills were small and were scattered over the whole nation. These facts, here briefly stated, require fuller explanation.

Raw Material.—Before the Civil War wool growing in America was part of general farming; therefore, the flocks were small numerically and except for brief periods were not carefully bred. Even when sheep raising is a principal business and not a farm by-product it is extremely difficult to approach uni-

formity in the quality of the wool; probably no other raw material is so variable as wool. On one sheep there are at least four qualities: (1) that along and near the spine, (2) that on the flanks, between the thighs and shoulders, (3) that on the neck and rump, and (4) that on lower neck and legs. Throughout a flock no two sheep in one season yielded exactly the same grades of wool. Since the quality is influenced by the food the sheep eat, the soil over which they graze, and the weather, no two flocks in one year produce the same quality of wool and the same flock will change from one year to the next. On the sheep's back the wool is protected by an oily exudation called yolk, grease or degrass. This catches dirt, and the wool itself picks up burrs, leaves and small sticks. The weight of this extraneous matter ranges from 10% to 80% the weight of the wool "in the grease." Before wool can be manufactured the grease and dirt must be removed. This introduces another irregularity into the raw material for sometimes it is sold "in the grease," sometimes as "washed" wool and sometimes as "scoured" wool. "Washed" wool is of two varieties: that which is washed on the animal before shearing, and that washed in the fleece after clipping. Sheep of the same sex produce different qualities of wool at different ages, and the wool of rams or wethers differs materially from that of ewes. Sheep of different breeds have marked contrasts in the wool and the wool pulled from dead animals is distinct from that sheared from living ones. In no two parts of one country nor in different countries is the material handled in the same way. There are different names for the same thing, and one term may have varying definitions. The raw wool is wrapped in bales, bundles and packages whose shape and weight varies between places.

Hence, to provide manufacturers with uniform raw materials every fleece must be pulled apart, and sorted into grades. This presupposes wool merchants, professional wool sorters, and a wool market. None of these was common in America until after the Civil War. Until 1825 every wool manufacturer bought his raw material direct from farmers and the majority continued to do so for many years afterwards, although about 1830 a few wool merchants started in Boston, New York and Philadelphia. Boston, which is now the world's greatest wool market after London, had,

as late as 1841, only two wool houses and one wool broker. Down to the present no one has discovered a standard unit of raw wool upon which can be based a "future" market, which results in the paradox that the raw material for which there is no speculative market is more speculative than one such as cotton where the future price may be hedged.

Because of the situation in regard to raw material every early wool mill was a complete entity. It took whatever wool was available in the neighborhood and sorted it into grades. All the preparatory and manufacturing processes were conducted by the mill. Having many grades of wool, the mill was forced to manufacture several products. Some of the first mills continued the handicraft system of manufacturing upon commission to the consumer's order, the latter furnishing the raw material. Under the circumstances it was impossible for any mill to specialize upon one process, or to make one product from a single grade of wool. Since specialization and standardization are the necessary preliminaries to large-scale production, it follows that all the wool mills were small. A little mill turning out a list of products cannot reach distant markets for it has no advantage in low costs. Therefore, every section of the country had its own small wool mills. Probably no other product made by machinery under the factory system was so distributed in its manufacturing units as wool before the Civil War. In 1860 there were 1,263 wool factories in the United States, located in 42 states and territories. To be sure, 80% of them were in Massachusetts, New York, Connecticut, Vermont and Pennsylvania, but such a scattering in five states is not a localization and this semblance of concentration merely reflected the massing of population near the Atlantic. That they were small is indicated by the fact that they averaged 34 wage earners each.

To get a true perspective on this picture one must know that Great Britain in the period between our Revolutionary and Civil Wars produced several times as much wool per capita or per acre as we did, and had a choice of all the world's wool after 1826, when duties were reduced, and particularly after 1849, when all import duties were removed. Because wool manufacture was a centuries-old industry in Great Britain before the factory system

was instituted, the machine production of woollens inherited a minute subdivision and specialization of functions. There were staplers who bought and cleaned raw wool, sorters who graded it roughly, and resorters who separated it into finer distinctions as to grade. There were combers who took certain grades and prepared the wool into "tops," a preliminary to spinning, and others called carders, who took other grades and prepared them differently for spinning. The spinners came next, each specializing upon the output of definite kinds of yarn. Each variety of yarn was sold to different weaving specialists, none of them producing more than a narrow variety of cloths. The cloth went to finishers, of which there were four or five specialists. No British mill was a complete entity, none performed all the operations and not one depended solely upon local raw material. This minute specialization allowed large-scale production and a perfection of quality for each grade of cloth that we could not approach. Before the Civil War the only American center that foreshadowed a specialization in wool manufacture was Philadelphia. This city almost from its start had been noted for its manufactures of wool and in its long experience had evolved many of the subdivisions we have noted among the British. Specializations were current in Philadelphia before the factory system was known, so that like the British, the introduction of machinery into the Philadelphia wool industry did not disrupt the distinctions set up by the handicraft system.

Lack of Male Labor.—Quite as important as any of the factors just mentioned in obstructing the progress of wool manufacture was the fact that it required male labor. The small scale of operations and the necessity for frequent change to meet the demands of customers or to fall in with variations in style, necessitated skill upon the part of the labor employed. Inasmuch as there was little standardization of product, there could be no corollary standardization or specialization of machines for certain types of work. Instead, the machines had to be adjustable, and change in product was produced through the skill of the manipulator. The beauty or perfection of any piece of wool cloth was vitally dependent upon the expert workmanship of the employees

in the mill where it was made. This threw the burden of wool manufacture upon the people employed and was the chief reason why men alone were serviceable for that kind of work. But the large rewards offered outside of the factories in the exploitation of natural resources tended to draw ambitious men away from the mills and shackled manufacturers in their efforts toward increased production or enlargements of plants. The employes who did consent to remain at their spinners or looms were bribed, so to speak, by relatively high wages, with a consequent weighting of the pay-roll that put wool mill owners at a competitive disadvantage with foreign producers.

Product.—Since the output of wool mills was mainly for use as outer garments for men and women and inasmuch as fashion constantly changed the type of goods for these purposes, there were few articles whose normal steady demand could be depended upon to maintain operations in a wool mill. That is, there were few staples whose manufacture would pay most of the expenses of a wool mill, while profits could be speculated with in specialties. Lack of staples also prevented large-scale production of any one of them. Sheeting and cotton duck were the staples that founded the early cotton mills, while the printing of Bibles and dictionaries paid the expenses of some publishers who took “fliers” in novels. The wool manufacturers, for the most part, were forced to gamble in specialties to meet caprices of mode and had no sustaining staple to carry the load of their business. Hence, profits were either a feast or a famine. This condition was conducive to frequent changes in ownership of mills, and kept the plants small.

Flannels and Blankets.—Yet there were a few products that could be classified as staples. Among them were flannels and blankets, both of which were often made in the same mill. Flannel was a cloth produced from woolen yarn which was but slightly twisted in spinning, and hence was soft and elastic. Our native wool was well adapted to this use and the manufacture of flannel was relatively simple. The highest grade of flannel (sometimes called “cricket cloth”) was used for men’s shirts and women’s blouses, while the poorer grades were fashioned into underwear

for both sexes, and into petticoats for women. Wales had for centuries specialized in flannels and the best grades used in America were imported from that part of Britain. The poorer grades which we made in large amounts had to meet the competition of flannelette turned out by certain of our cotton mills. Blanket cloth, whose manufacture was akin to flannel, used just the variety of raw wool which we produced in America, and the demand was continuous and universal. It is worth noting that the only wool mills which until the Civil War enjoyed any continuity of profits were those that made flannel or blankets, or both.

Men's Wear.—For men's wear there were two cloths that were in more or less steady demand. One was satinet, the other cassimere. The former was made with a cotton warp and a filling of coarse native wool or shoddy. In finishing the cloth the cotton was entirely concealed, and a pattern was printed on the surface. Satinet sold for about 25 cents a yard, which was 10 to 15 cents cheaper than cassimere. Cassimere was an all-wool cloth made from carded yarn with the pattern woven in the goods on the loom. Until the Civil War it was the universal substitute for broadcloth in America for the making of men's suits. When department stores were first started they had a "Men's Department" wherein were displayed satinet and cassimere cloths for the inspection of wives and mothers who bought the goods and "trimmings"—buttons, buckles, and bands—to make at home the nether garments for the men of the family.

Indeed it was the establishment of the mode for trousers that started and supported the mills that made satinet. In the Middle Ages all of men's outer clothing below the waist was in one piece and called "hose." Later fashion decreed that men should wear a full garment about the hips. This was called "breeches" and was separate from the leg coverings ("stockings" or "leggings"). Until the French Revolution breeches and stockings were a gentleman's dress. Sailors and laborers wore a loose, long-legged garment called "trousers." With the rise of the proletariat in France their common dress, trousers, became the mode. The elaborate costly breeches and stockings of gentlemen were banned. The fashion for trousers crossed the Atlantic and became universal

in America. The first trousers reached to a man's calf where they met half top-boots, but the succeeding modes carried the trouser legs to the insteps under which they were fastened by a strap. In Britain, the word breeches was transferred to long trousers but here breeches was retained for "shorts" and became obsolete with them.

To indicate distinction in grade we adopted the word pantaloons (soon clipped to "pants") for the cheaper varieties of trousers. The term pantaloons apparently was derived from a well-known Italian buffoon name Pantalone who, in order to appear ridiculous in his day, was the first to wear "breeches" and "stockings" all in one piece. The comedian in turn derived his stage name from Pantaleon, the patron saint of Venice. In America "pants" ordinarily were made in the home from satinets purchased in the stores. Trousers and suits generally were made from cassimere or broadcloth. Suits of these two materials were fashioned by tailors, although mothers sometimes made their sons' trousers from cassimere.

Since satinets were the principal material for pants, and inasmuch as pants clad the masses, the mills that manufactured satinets were reasonably assured of a market. Inasmuch as the pattern was printed on satinets any last minute shift of popular taste for stripes, checks, and colors could be met by changing the printing blocks and dyes. Satchet mills consequently escaped some of the vicissitudes suffered by fellow wool manufacturers. By 1836 more power was used for the manufacture of satinets than for any other two wool cloths.

Cassimere, finding its market among the classes, was swayed by every breeze of style. Although some kind of cassimere was always in demand, the manufacturer who could not furnish the particular kind that for the moment was wanted, saddled his shoulders with woe. Only the cheaper cassimeres sold for making pants had a degree of standardization in pattern, and a steady market.

Women's Wear.—For women's outer wear flannel corresponded to satinets, and cashmere to cassimere. The original cashmere cloth was spun and woven from the downy undercoat of

the Kashmir goat in India, and later from goat hair derived from cashmere goats domesticated and finely bred in France. The cashmere cloth of commerce in Britain and America, however, was made from the softer varieties of native sheep-wool. Some of our merino wool was well fitted for manufacture into cashmere. This cloth, however, was even more subject to the sudden shifts of mode than cassimere, and it was a rare manufacturer who steadily could prognosticate demand. Some made both cassimere and cashmere, while many alternated from one to the other.

Shawls were fashionable for a very long time among women. The original shawls came from the Orient and Asia Minor where they had been made and worn for thousands of years. The best ones were found in Kashmir where they were made with a silk warp and worsted filling. The manufacture of this variety began in Britain in 1784 and Paisley in Scotland became the most famous center of production. Kashmir shawls sold here sometimes for \$4,000 and some Paisley shawls were valued around \$1,000; both were honored heirlooms. Since we possessed neither silk nor worsted we could not make the best shawls, but in cheaper varieties we were self-sufficient. Most of these were made from cashmere cloth decorated with fringe. Shawls, therefore, were part of the market for the manufacturers who produced cashmere.

Stockings.—Wool was the principal material for stockings until the Civil War. The manufacturers of the stocking yarn sold it to others who knitted the stockings by the factory system. Much yarn went by way of retailers to housewives who knitted stockings, mittens and mufflers for the family.

The art of knitting by hand may be older than weaving; at any rate, it has been practiced for ages. But knitted stockings were not common in Britain until about 1560, when Queen Elizabeth's joy in a gift pair caused stocking knitting to become a society occupation. From the court the vogue for knitted stockings to replace felt or cloth spread to the humblest ranks, among whom knitting for market added materially to the family income. Because of a romantic attachment the Rev. William Lee, of Woodborough, England, in 1589, invented a frame by which a large amount of straight knitted strip could be produced. His frame

was first adopted at Rouen, France, and later at Nottingham, England.

We inherited the knitting frame, and large numbers of stockings were made by it in or near Philadelphia, Newark (New Jersey), and the Mohawk Valley in New York. Early in the 19th century a machine was invented that improved the product of the older frames because it produced a continuous circular web. Although this invention eliminated the leg seam and reduced the cost of the web, it was still necessary to employ hand knitters to shape and close the heel. The shape of the stocking at the calf and instep was given by pressing over boards but the "shape" was destroyed by the first trip to the tub. The Shakers of Enfield, New Hampshire, made a noted stocking in which an entirely hand-knitted foot was joined almost invisibly to the machine-made leg web. Shortly after the Civil War there was invented a machine which not only produced a circular web but widened and narrowed it to conform to any leg shape and also knitted a shaped foot all except a small closing seam. This machine was about 200 times as productive per laborer as the old hand frames and almost entirely removed stocking manufacture from household industry.

Not only were nearly all stockings made of wool until the Civil War but most of them were white or gray in color. Black stockings were worn only by inmates of institutions and by servants, although a lady in mourning might wear black silk stockings. Cotton stockings were not generally popular and those that were worn were imported from Chemnitz, Germany, where the countryside specialized in their production. It was not until the great scarcity of wool during the Civil War that cotton stockings were introduced as a war emergency product and were retained afterward by popular favor.

Until the middle of the last century, therefore, the manufacture of wool stocking yarn was a steady business, and the production of wool stockings by factory methods, an enterprise that constantly encroached upon family industry.

Carpets.—Like so much that relates to wool, carpets originated in the Orient, Persia probably being the first producer. In

the Far East carpets were not so often floor coverings, as hangings for the walls, mantles for tables and divans, and cushions to kneel upon in prayer, to sit upon, or to lie upon in sleep. When first brought to Europe carpets were used in the Oriental manner, the floor being covered with sweet rushes, straw and sawdust. The European manufacture of carpets began in France about 1600, the methods being taken directly from Persia. The Huguenots brought carpet manufacture into Britain and the industry took firmest root in Scotland. It was the Scotch workmen who established the American carpet manufactures. Before the Revolution the only common floor coverings in America were the rag rugs of household manufacture. Captain Kidd is said to have possessed the first Turkish rug in America. A few wealthy Dutch merchants had Oriental carpets in their New York houses, and a few Scotch carpets were in private homes.

It was in 1791 that William Peter Sprague started the first carpet factory in the United States, locating it in Philadelphia. In 1827 H. R. Knight set a carpet factory in Hartford, Connecticut, and the following year one was established at Thompsonville, next door to Hartford. At this time a Medway, Massachusetts, works of 1825 was merged with a company then beginning in Lowell. Before 1840 there were a score of carpet factories in New England, New York and Pennsylvania, but all of them wove upon hand looms.

Erastus Brigham Bigelow, a young but already successful inventor, turned attention to carpet weaving and, in 1845, patented the first power loom for weaving ingrain carpets. Later he produced machines for making the finer grade Brussels and Axminster carpets. When applied to Brussels carpets the increase of yardage per day was six times, and upon Axminster carpets was ten times, over the hand looms. American machine-made carpets before the Civil War were the best and cheapest of their kind in the world.

At different times the older nations have picked out some one item in American households to illustrate both how prosperous the common man was here and how recklessly he spent his money. The carpet was the first of these stereotypes; it was followed by

the parlor organ and piano, then the bath tub, and now the automobile. It is certain that after 1840 there was hardly an American workman of the most humble occupation whose home could not boast at least one carpeted room. Seemingly, every American, even before Bigelow made it possible to realize the ambition, felt that to maintain his social standing he must have carpeted rooms. The manufacturers were able to supply a carpet for each social class. For the humble there were three grades of ingrain carpets, while the more affluent, wishing pile carpets, were offered Brussels, Wiltons, Axminsters and Chenilles. Carpeted floors did not lose their social distinctiveness until the nineties. Men whose hair now is beginning to be streaked with gray will remember that the song "Ta, Ra, Boom-de-ay" mentioned the social distinction conferred by a carpet. A verse of that popular ditty ran

"I had a girl in Baltimore
Brussels carpet on the floor
Horse cars running by the door
What could a fellow wish for more."

Philadelphia and Amsterdam, New York, became the leading centers of carpet manufacture, but noted companies were located at Hartford and Thompsonville, Connecticut, and at Lowell, Massachusetts. Until worsted manufacture was established in America after the Civil War, the carpet mills were the largest and most concentrated of any branch of the wool industry. Their raw material was all imported and having no American competing wool supply entered our ports either at the lowest duties or free. The carpet mills had a product which then was little subject to changes in fashion, and a market whose demand was apparently insatiable. Moreover, some of the most fortunate carpet mills possessed machinery in whose use they were protected by patent rights or leases from the patent owners. All of these features marked the carpet industry as different from most wool manufactures before the Civil War.

The Civil War—a Dating Point.—The war between the states in 1861 is a convenient period to separate the history of wool manufacture into two distinct eras. After the war there were notable changes in sheep raising, in the kinds of wool cloth

manufactured in America, and in the relation of the tariff to the wool industry.

Range Sheep.—Sheep raising was a part of general farming until about 1840. From about that time the range method of sheep herding became ever more prominent. After the trans-Mississippi country was opened following the Civil War the herders of sheep contested the range pasturage with the cattle barons. At the same time, sheep raising in California took a leading place in that state, and the state for a time became a national leader in wool production. Eventually, the slopes of the Rockies, Cascades and Sierras were favored for sheep. In winter the sheep browsed over the foothills and plains but in summer were driven high into the mountain pastures. Flocks of 3,000 to 5,000 head were usual, which was 100 times as many sheep as farmers had formerly kept in their folds.

For the range method of sheep raising the merino was the choice breed. Merinos have a strong flocking instinct which makes easy the driving of large bands. Merinos, too, were expert foragers, living where every other browser, except a goat, would starve. The yield of wool per acre was highest on the comparatively small animal such as the merino, for the reason that a sheep twice as large as the merino fails to produce anywhere near as much as twice the amount of wool. Large bodied sheep do not flock as well as merinos nor are they as well able to endure hardships. There was no large market for mutton or lamb near the sheep ranges. Americans at no time have been fond of sheep meat and the only large market for lamb has been in cities and towns close to the Atlantic and in California. Hence, a wool sheep on the range was a more certain asset for large-scale operations than a larger sheep yielding meat as well as wool.

These new features in sheep raising had a direct effect on wool manufacturing. For the first time there was no dearth of home grown wool. The $2\frac{1}{2}$ pounds of wool produced per capita in 1840 increased to more than 5 pounds per capita in 1885. Secondly, the remote location of the ranches in respect to mills made a wool marketing system necessary. The concentration of the sheep business together with the large numbers in the special-

ized areas made marketing easier. The marketing system enabled manufacturers to buy from wool merchants specific grades of wool sorted from many fleeces. Yet the favor shown for merinos by ranchers caused the bulk of the domestic clip to fall within the medium grades of wool. To be sure, most of our wool manufacturers needed the medium grades, but the lack of other domestic grades hindered manufacturers from producing yarns and cloths based on such grades.

Carded versus Combed Yarn.—Men in the wool trade divide yarn into two great classes, that which is carded and that combed. Carding is a process, preceding spinning, in which the raw wool is opened, disentangled, cleansed of foreign matter, and the coarsest fibers removed. Carding does not lay the wool fibers strictly parallel nor select the fibers according to length. Carded wool ready for spinning is soft, elastic, and irregularly surfaced. The yarn when spun retains these characteristics. Cloth woven from carded yarns requires many finishing operations.

Combing differs from carding in that the comb rigorously selects the longest fibers and rejects the short ones. The long fibers are laid parallel by the comb. When spun the combed yarns are harder twisted, stronger and smoother than those carded.

In America until about the Civil War almost all wool yarn was carded, and almost none combed. The reason for this was the absence of long wooled sheep. In England and Scotland, where mutton was highly regarded, the meat sheep predominated. It was from these that combing wools were obtained. In only a few regions in America were meat sheep favored and these were generally crosses with the merino and so were not the best producers of combing wool.

In addition, wool combing was a highly specialized handicraft. Britain, having engaged in wool combing for four hundred years, had the best and largest number of combers. We had scarcely any, for our situation did not encourage the craft.

The Introduction of Worsted.—This country and Canada entered into a Reciprocity Treaty in 1854 which extended to 1866. The Canadians like their British cousins had a taste for

mutton, and consequently, most of the sheep across our northern boundary were of the meat variety. The wool from these sheep was well fitted for combing and, under the Treaty, freely entered the United States. This wool gave us for the first time an opportunity to manufacture yarns and cloth based on combed wool.

About the time we signed the Treaty, the efforts of British inventors to devise a wool combing machine ripened. Among the inventors of combing machines were Samuel Cunliff Lister (Lord Masham), Heilmann, Donisthorpe, Sir Isaac Holden, and Noble.

These two sets of circumstances set the stage for Americans to enter upon the manufacture of worsted, a cloth made from combed yarns and named from the town in Norfolk, England, where the cloth was first woven. Our worsted mills began with the craze for muslin delaine. The French, in 1833, produced an all-wool cloth they called *mousseline de laine* ("muslin of wool"). This was a light weight, closely woven muslin-like wool material that was instantly popular among women in France, Britain and America. The British, thereupon, placed in the market a cloth they called muslin delaine. This was similar to the French material but had a cotton warp, and so, sold for less than the French. In the forties muslin delaine everywhere north of Tennessee displaced printed cotton-muslins and cotton-lawns.

Since muslin delaine was part cotton it was natural that mill men at Lawrence, Lowell, and Manchester, New Hampshire, should become interested in manufacturing it. Before 1860 the Pacific Mills, the Hamilton Company, and Amoskeag all were large producers of muslin delaine. The first combing machine operated in the United States was placed in the Pacific Mills at Lawrence, in 1854.

The Civil War was a great spur to worsted manufacture for certain of the worsted cloths were used for army uniforms. Being smoother, worsted uniforms were easier to keep clean and in good condition and absorbed less moisture than the rough surfaced woolen. For women's wear, too, many cotton fabrics were scarce during the war, so that women tried various types of light-weight worsted dress goods. Many cotton mills with curtailed raw materials turned to the manufacture of worsteds. Some of these remained in worsted manufacture after the war.

Growth of Worsted Manufacture.—The three original worsted makers of 1860 had the company of fifteen other manufacturers six years later. These were in New England, New Jersey and Pennsylvania. Lowell, with six mills, had the largest number of individual worsted enterprises.

In 1866, however, the whole worsted industry seemed about to collapse for the Canadian Reciprocity Treaty failed of renewal. This threatened to cut off the supply of combing wool. Although the Treaty was not continued the fears of the worsted manufacturers were not realized because two factors favored them. One was the imposition of high tariff rates on imported worsted cloth. The other was the improvement by French and Belgians of machinery to clean and separate dirty and knotted Argentinian wools so that they could be combed. The combing machinery itself was gradually perfected so that the differences between "carding" and "combing" wools were wiped out. Our own domestic merino wools in time could be combed and after 1900 there was no wool produced anywhere that could not be combed. More than ten million dollars was spent in minutely perfecting three types of combers.

Except for uniforms, worsted cloth had been confined to women's dress goods, braids, and some carpet yarns. But in 1867 the worsted mills started to turn out goods for men's wear in competition with broadcloth, cassimere and satinet. For twenty years the carded and combed fabrics pitted against each other for masculine preference. By 1890 it was easy to foretell that worsted would win and by 1909 the worsted branch of the wool industry used twice as much wool as all other branches together.

Features of Worsted Manufacture.—The worsted industry as developed in America has shown characteristics that were directly opposite from those in the woolen industry. The first three worsted mills were capitalized at about one million dollars each. These, however, were unusually large, for the average investment per mill from 1870 to 1923 ranged between 100,000 dollars and half a million. The investment in wool mills, on the contrary, has rarely exceeded 100,000 dollars and often has been less than that. The same contrast in size is noticeable when the

number of wage-earners per plant and value of output per mill are considered. For wage-earners, the worsted mills have exceeded the woolen from three to five times, while in output the same ratios existed. Compared with the woolen industry the units of the worsted industry were large-scale.

The woolen mills have been scattered over the nation ever since the business began. From 1860 to 1890 the number of mills exceeded 1,000 and at times was over 2,500. These were spread over most of the states of the Union. From 1914 to 1923 the number of wool mills has been about 500, located in 22 states. The worsted mills always have been concentrated in Massachusetts, Rhode Island, Pennsylvania and New Jersey. A few mills have been located in Maine, Connecticut, New York and Wisconsin. In the four leading states the cities of Lawrence, Providence, Philadelphia and Passaic always have led in worsted production. That is, the woolen industry has had almost no localization while the worsted has been more localized than cotton manufacture.

The worsted mills, too, have been much more specialized than the woolen. Not only was the range of products narrower but the worsted mills often did not include all the processes from raw wool to marketable cloth—some processes were left to specialists. For example, the machinery for the preparatory processes in worsted manufacture was much more elaborate and costly than the analogous steps in woolen production. More than half the cost of worsted yarn was in the preparatory stages prior to actual spinning. In Britain this preparatory work was a separate branch within the worsted industry and to a certain extent that has been true also in America. The Arlington Mills of Lawrence have been the largest specialists in preparatory processes.

While it is true that more processes are required for the manufacture of worsted than for that of woolens, machinery has been more generally installed for the carrying on of these processes. Hence, there has been less dependence upon highly skilled men in worsted manufacture and more need for trained tenders of machines. This work could be done by women. From the beginning of worsted production the number of women employed has exceeded the number of men, while the opposite was true of

woolen manufacture. In 1880 in worsted mills the women employes exceeded the men by $16\frac{2}{3}\%$, while in woolen mills the men were more numerous by 20%. Later, in worsted mills the division between men and women became more nearly equal but in woolen mills the men still outnumber the women by a wide margin.

It is apparent that the worsted industry not only was distinct from the woolen but that worsted manufacture more closely duplicated the features of cotton manufacture than the sister branch of wool. For that matter, worsted and cotton manufacture have often been carried on by the same capitalists, sometimes both businesses in one plant. This has been true not only because the external manufacturing features of the two textiles were similar but for the reason that the worsted yarn so closely resembled cotton that the two might be mixed without detection except by an expert upon careful analysis. Worsted also combined readily with silk or mohair. By reason of these possible combinations which might be supplemented with elaborate effects by weaving on a Jacquard loom, worsted could be turned out in a range of patterns and construction not possible for woollens. The worsted industry as a consequence has forged ahead, keeping pace with cotton manufacture, while the woolen industry has lagged. The carded wool industry which was supreme in 1860 has had to yield place to the combed wool, notwithstanding that the modern carded wool business has about three times as much capital invested in it as in 1860.

Wool Manufacture and the Tariff.—Since 1789 the tariff on wool and wool cloth has been changed 29 times. Generally, a tariff on wool has remained in force four years—one presidential administration—but twice the law has been changed within one year of enactment and four times a law has stood unchanged for eight years. The laws before 1816 were designed for revenue, but after that date were either frankly protective or intended by progressive reductions to lead to free trade. The Civil War tariffs were high, but more for revenue than for fostering the wool industry in all its branches; but in 1866 the tariff on wool purposely was made high to protect domestic enterprise. This practice with a few recessions prevailed until 1894, when raw

wool was put on the free list. Even then wool cloth was protected. The Republicans restored the raw wool rates in 1897 and kept them up until President Wilson's administration in 1913 again put raw wool on the free list. However, in the next year the World War caused the Government to seize control of wool with an effect more stifling than any tariff. In 1921 an Emergency (High) Tariff was passed and the next year the highest duties ever imposed were levied.

Probably the tariff on wool and wool cloth has produced more argument and left a bitterer trail of dissension than the duties on any other commodity. At every tariff revision since 1816 the changes in the wool rates have been the center of heated controversy. First of all, tariff tinkers have had to consider that wool has had two groups financially interested in it; first, the sheepmen and, secondly, the wool manufacturers. Any protection to sheep raisers by duties on raw wool had to be compensated to manufacturers by equivalent duties on wool cloth. It is said that the manufacturers have cleverly induced Congress to accept a standard of equivalence which, in reality, gave manufacturers a concealed protection. In addition, at times, Congress has decided to protect domestic wool cloth production and so has added a liberal margin to the equivalent duties. After the rise of American worsted manufacture, the wool manufacturing group has had two camps, because the standards used for taxing wool imports and imported cloth have not had an equal effect on the carded and combed wool users. The three groups of interested parties—growers, carded and combed wool manufacturers—have been opposed in Congress by those representatives whose constituents were outside the three interested groups. These representatives voiced the public discontent over the excessive burden borne by all the people for the benefit of the few wool growers and manufacturers. Then, too, the wool schedules were the battle ground of theorists; those who had a religious faith in the protective principle, those who were fanatic in support of free trade, and those who believed there was truth in each of the theories and tried to establish a compromise middle ground.

As a factor influencing manufacturing, the wool tariff has been constant in inconstancy. Never could manufacturers count

upon a settled condition as regards raw materials. Likewise, the domestic market for cloth was continually unstable by reason of shifts in tariff pressure. Since manufacturing is always for a future market, it is never free from speculation, but the gambling element is least where the raw material and goods markets are most settled. Wool manufacture never has enjoyed stability and probably there is no other industry which needs it more, because every other factor in wool manufacture is extraordinarily variable. Hence some wool manufacturers claim that, notwithstanding incidental temporary inflations of profits due to tariff provisions, the net result of the tariff has been detrimental because it has added one more unpredictable factor to an industry already as uncertain as the surface of the ocean. These manufacturers—a minority to be sure—have said that the tariff could be high or low, so far as they were concerned, but if it were consistent in either state it would be beneficial. This condition, however, never has been experienced. The effect of changes in duties has not been limited to the grades and prices of raw materials available, nor to the varieties of cloth possible to manufacture, but each tariff shift has been multiplied and scattered over manufacturing costs in such items as insurance, taxes, interest, inventories, and margin of free working capital. The tariff has raised the total cost of production so that Americans have been unable to sell domestic wool cloth anywhere except in the American market. This market, in turn, could not be supplied with every grade and variety of wool products. In some cases, too, reliance upon tariff protection probably has lessened the managerial and mechanical efficiency of wool manufacturing units. Pampering seldom produces strength.

Changes in World's Wool.—From the day machinery was installed in wool mills no nation manufacturing wool cloth has been self-sufficient in raw wool. The advance of steamboats and railroads has made cheap or free land a critical factor in sheep raising for wool. In America the sheep business was transferred to the semi-arid plains of the West and the foothills and heights of the western mountains. The edges of the deserts of Australia, likewise, were clothed with flocks. The cheap or free lands of

New Zealand, South Africa and Argentina were devoted to large-scale sheep herding. Since wool was valuable in proportion to its bulk and weight and did not deteriorate unduly, it could be shipped from the remotest regions to the industrial nations.

But the invention of refrigerator cars and ships made it possible for places far outside the centers of population to turn attention to the meat possibilities in sheep, in addition to the fleece. The hunger of the East-End Londoner could be partially relieved by the shepherds of Patagonia, while the factory hand of North Philadelphia could grace his table with mutton from Montana. Instead of breeding sheep for the yield of large quantities of high-grade wool, the fold masters bred for a double purpose animal, one that was valuable both for meat and for wool. In attaining this result, each sheep and the flock furnished a greater revenue, but the quality of the fleece was lowered.

Since all the range shepherds of the world have been more or less allured by the profits from cross bred sheep, the number of pure bred sheep has been reduced. From the manufacturer's viewpoint this means that the raw material of late years has fallen in quality.

In the United States the above is not only true but the sheep ranges have also shrunk. Much of the mountain pasture has been included in the National Forests. Although shepherds have been permitted to run sheep there in the summer it has been at a charge per head. The Government's policy, too, has favored small-scale operators, each one of them allotted his share of grazing. The pasturage being limited, the large operators have reduced or abandoned their business. Whereas flocks of 5,000 once were common, they now rarely exceed 1,500.

The lower range on the plains, too, has been circumscribed by cattle men, farmer settlers and irrigation projects. The range had to be bought or leased by the sheep men if their business was to survive. Along with purchased or rented land went added expense for fencing, winter shelter, and warehouses for food to insure against failure of the range. That is, land formerly free attained value. To make the best use of this value, sheep must compete with other uses of the land. At the same time, the American sheep compete against foreign animals grazed on land

that not yet has acquired the value of our land. Under these circumstances, the American sheep are forced on the cheapest, poorest, most remote sections of the range.

Out of these factors two results flow. Sheep are likely to be less numerous in the range country which has furnished the majority of our fleece animals since the Civil War. This deficit, however, may be offset by an increase of sheep upon farms as a part of the agricultural economy. Such sheep, however, would probably be cross breeds or meat animals. In any case, the second result follows, namely, the cost of rearing sheep is raised. From this it may be induced that American manufacturers face higher raw material costs, for either our sheep will be retained by a tariff on wool, which raises the price to manufacturers, or sheep raising will be lessened, which by decreasing the quantity in the world enhances the price. Our deficit of sheep could not be fully met by increases of foreign flocks, for these too are influenced more or less by the same sort of constrictions that hem our folds.

Shoddy and Mungo.—Up to 1813 wool rags were used only for fertilizers. In that year it occurred to a man of Bately in England that no matter how worn wool cloth was, the fibers of which it was composed were not destroyed. If the rags were shredded to the original fibers these then could be treated like virgin wool; that is, they could be spun and woven into new fabrics. The Bately enterprise did this with entire success with the soft rags from blankets, flannels and stockings. Soon afterwards the same practice was adapted to the hard rags from broadcloths and tailors' clippings. It is said that Yorkshire workmen's dialect furnished the names "shoddy" (should go) and "mungo" (must go) for the two materials. At any rate, wool reworked from soft rags has been designated as shoddy and from clean hard rags as mungo.

Between 1813 and 1850 the British shoddy and mungo trades advanced rapidly, building a whole new organization in the collection and sorting of rags, the shredding of them to fiber and the spinning of reworked yarns. These fibers and yarns were used for fillers in overcoats, blankets, flannels, broadcloths and, in short, in nearly all the carded wool products. Indeed, mungo was

used so much to cheapen broadcloth that the latter lost its social standing and so prepared the way for the ascendancy of worsted, in which naturally neither shoddy nor mungo so easily could be used, since it was made of combed long fibers. The British shoddy mills were supplied with rags collected from Russia, Egypt, Turkey and China, as well as from the Empire itself. The tattered shreds that disclosed the purulent sores of an East Indian mendicant, after transmutation in a shoddy mill might as a dolman drape the graceful shoulders of a Windsor princess. By 1850, the British shoddy mills produced as many pounds of reworked fibers as our total wool clip of that year sheared from 21½ million sheep.

In that statement lies the economic importance of shoddy and mungo. If it were not for these two materials countless humans would shiver. By virtually adding to the world's wool supply an annual increment of many million pounds, shoddy and mungo not only hold down the price of virgin wool products but provide a cheap material that keeps the workers of the world comfortably warm. Wool is an excellent illustration of the indestructibility of matter, for it is reworked not once only but perhaps a dozen times. We probably are still using some of the wool clip of a half century ago, for except what is burned, buried and drowned, little wool is destroyed beyond all usefulness. Even the dust and dirt of the shoddy mills goes into fertilizer.

American Shoddy.—It was more than a quarter of a century after the first Bately experiment that M. Stearns built, in 1842, the first American shoddy mill at Quechee, near Woodstock, Vermont. From that beginning shoddy mills appeared elsewhere in Vermont, New Hampshire, and New York. By 1859 there were 30 plants reworking wool; the number varied thereafter from year to year, but over any decade there was generally an increase. The largest number reported was 78 in 1919, as a result of the world scarcity of available wool during the World War. Ohio employs the most men in shoddy manufacture, followed by Massachusetts, New York, Pennsylvania and Rhode Island.

Here, as in Britain, the shoddy mills gave rise to an intricate organization of rag collectors. At the base are the peddlers who

buy or barter for rags. The peddlers turn their rags over to wholesale junkmen, who make a rough assortment and sell the results to specialized sorters. The shoddy trade recognizes from 175 to 570 grades of sorted wool materials.

About half the shoddy mills specialize in reducing the rags to fibers and carding or combing them ready for respinning. The other half of the shoddy output is by wool mills that use the fibers to mix with virgin wool in the production of yarn or cloth.

Until the Civil War shoddy in America was limited in use to paddings, carpets, and covers for furniture. The war caused it to be employed for uniform cloths and overcoatings for the soldiers and similar clothes for civilians. It was introduced as an adulterant, which gave it a bad reputation in the United States. The very name has become figurative for reproachful acts or things. Yet we produce about 100 million pounds of it per year, which is equivalent to the clip of about 25% of all our sheep. Shoddy is indispensable. The only detraction concerning it is when it is passed off for what it is not, namely, virgin wool. To escape the traditional unfair odium the shoddy industry might follow the example of the manufacturers who changed the name "artificial silk" to "rayon."

The American shoddy business never has reached the proportions attained by the British. This is due, in part, to the fact that shoddy is useful primarily in the carded wool branch of manufacturing, which, with us, has long been overshadowed by the worsted. In part, the higher wages of American workers enable them to purchase clothing and other wool materials in which shoddy has small share, and our manufacturers cannot sell any wool product to foreigners who might desire cloths cheapened by admixtures of shoddy.

Association of Wool Manufacturers.—The manufacture of wool had been conducted in this country more than half a century before the proprietors attempted to combine for any purpose. It was the disturbed conditions at the close of the Civil War, discouragement over tariff fluctuations, the waning of the Canadian Reciprocity Treaty, and the infusion of an aggressive spirit from the few worsted manufacturers that brought about, in 1864, the

organization of the National Association of Wool Manufacturers. The first annual meeting was held in Philadelphia, in 1865. At that time there were about 2,000 wool mills, most of them very small, sprinkled over 42 states. That statement explains why an association was so long in abeyance. It took an extraordinary situation to force cooperative action. The National Association, in 1865, set up standing committees on Finance, Statistics, Machinery, and Raw Materials. It also appointed a Secretary, whose office was the center of the Association's activities between annual meetings. The first important business of the Association was the drawing up of tentative tariff schedules, particularly the determination of a ratio between the rates on raw wool and different kinds of cloth. The Association's figures and the arguments supporting them were submitted to Congress, with the result that the tariff schedules on wool in the Acts of 1866 and 1867 were largely those prepared by the Association. The rates were the highest ever imposed and the ratios applied to cloth were said to conceal an extra "protection" to the manufacturers. The Association ever since has kept a wary eye on the tariff. Its statistical service likewise has been of service to its members.

In 1884 another association appeared in the wool industry. It was no rival of the National Association because it was limited to the spinning section of manufacture, as its name indicates, the National Association of Wool and Worsted Spinners. Its function is naturally narrower than the National Association.

In the two large wool markets of Boston and Philadelphia local associations were formed, the Boston Wool Trade Association and the Philadelphia Wool and Textile Association.

Distress Since World War.—The World War was as much a stimulus to the wool industry as to steel, for every wool mill in the country operated on government orders for uniform cloth, blankets and other military needs. The number of woollen mills increased and some worsted and cotton mills shifted to carded wool products. Moreover, the capacity of many of the mills was greatly augmented. In the steel industry, where similar war expansion occurred, it took five years for the after-war national

consumption to overtake the productive capacity. For the wool industry, unfortunately, no such post-war consumptive capacity has appeared; rather the reverse has been experienced. The slackening in demand for wool had begun before the World War and after the hiatus of the conflict the recession was intensified.

The first influence causing a falling off in demand for wool goods was the general system of heating houses from a central furnace. Central heating was installed in the homes of all classes. With central heat, lighter clothing and fewer accessories—scarfs, mufflers, shawls and fascinators—were not only permissible but desirable.

Another factor that has hit wool manufacturers is the smaller amount of underwear worn and the shift from wool and flannel underwear to cotton, silk and rayon. Short and narrow skirts, the elimination of petticoats and the fad for chiffon hose all have been reflected in the smaller orders drifting into the offices of wool manufacturers.

The rapid increase of installment buying of such commodities as automobiles, radios, talking machines and electrical household equipment has diverted much of that portion of the family budget that once was applied to clothing. The public not only wears less clothes, but what little it does, it purchases less frequently.

In explaining the distress of the wool industry the manufacturers stress the matters we have suggested. But much of the fault has lain with the manufacturers themselves. There have been so many small wool mills that the characteristic operation has been extremely individualistic. There has been much personal domination and sly secrecy about wool mill operation. Business honor in such a matter as the evasion of contracts has not been notably high. The rise of ready-made clothing both for men and women has imposed on wool manufacturers a stricter code of ethics with which some of them had but distant acquaintance when dressmakers, village tailors and house-mothers manufactured the clothing. In the present age of clothing factories also, narrow looms and short runs of cloth are obsolete. Yet many wool mills have machinery that is older than the men who own it or operate it.

Efforts at Solution.—With seven lean years in succession after 1920 the wool manufacturers set about relieving their own distress. One group of thirty manufacturers combined in a loom scrapping campaign. They bought the machinery of mills faltering upon failure and then destroyed the machinery. In 1927 some 1,000 looms with a capacity for five million yards were thus taken off the market. In 1926 a Wool Council was formed by the five leading associations in the wool industry. This Council has prepared complete monthly statistical information concerning production and consumption of various woollen and worsted goods. Facts replaced guesses as a basis for action. Several manufacturers also, in 1926, agreed to enter a cooperative national advertising campaign. In 1927 the manufacturers dallied with the idea of the appointment of a coordinator, or "Czar," a scheme first tried by organized baseball and by the movies, which later appeared in the building trades, and was adopted by the cotton manufacturers. No wool Czar had been appointed at the time these lines were written.

American Woollen Company.—The largest corporate combination for wool goods production was the American Woollen Company, organized in 1899 during the "trust" forming era. The original group included 60 formerly independent mills. Of these, 54 were in New England, 23 being in Massachusetts and 16 in Maine. The strength of the American Woollen Company was in the carded wool business. In this field the company controlled about 10% of the total number of mills and about 13% of the loom capacity. The large company for many years acted as a stabilizing force in an industry filled with small individualistic units. In the depression that hit the wool industry after the World War the American Woollen Company suffered severely. In 1926 it began a policy of closing permanently the smallest, most unprofitable plants in its organization. A dozen or more were thus eliminated.

Other large organizations engaged in wool manufacture are the Arlington Mills, Botany Consolidated, Hamilton Woollen Company, and the United States Worsted Corporation. The

Amoskeag Company and the Pacific Mills manufacture both wool and cotton on a large scale.

The wool manufacturing industry never has been wholly prosperous; it has always been more or less ailing. Compared with its associate textile, cotton manufacture, it has had a sad record. But the problems that always have confronted wool manufacturers have been intricate and complex. Despite the fact that many of their troubles may be traced to their own unintelligent management, the men engaged in the wool business have evidenced industrial heroism.

CHAPTER XVII

SILK

Introduction.—Si-ling-chi, wife of Ho-ang-ti, the third Emperor of China, at her lord's request investigated the silkworm to learn its habits and to make use of its product. So thoroughly did the Empress work that she founded one of the most important industries of her people, and she herself in consequence was elevated to the rank of Goddess. For four thousand years every succeeding Empress despite changes in dynasty was both a patron to and an artisan in the cultivation of silk. This imperial favor was not misplaced, for of all textile fibers, silk was the longest, finest, most elastic, strongest and with the most beautiful sheen.

Since China was self-contained and protected by mountains, deserts, and sea she kept the secret of silk manufacture for 3,000 years. However, silk fabrics and raw silk were carried by tortuous, terrible land routes to India, with which China had religious and commercial relations. Eventually other caravans transported the luxurious textile beyond India to Persia.

Probably the first acquaintance with silk by the West was brought about by the military expedition of Alexander the Great to India (325 B.C.). During the next three centuries the manufacture of silk slowly arose on the easternmost shore of the Mediterranean, three places becoming noted for the fabulous fabric. At Cos the women unravelled Chinese silk cloth and reweave it into gauze so fine that when worn it served less to conceal than to reveal. At Tyre and Berytus (Beirut) raw silk was imported by way of Arabia and manufactured into a cloth which when dyed with the murex purple was more valuable than spun and woven gold, for both the silk and the purple dye were worth more than their weight in gold.

Silk at Rome.—Rome, like Greece, discovered silk by war in the East, probably the Parthian War (54 B.C.) being the first

in which the armored, helmeted and bearded legionaries of Rome saw the sheer slinky sheen of silk as it fluttered in Parthian banners. Introduced in the Imperial City, silk, particularly the "woven mist" of Cos, was at first worn only by courtesans whose voluptuousness was rendered more seductive by the sheer, gleaming material. Cleopatra, too, clothed in silk, revealed her beauty to the two famous Romans. Moralists ranted when Roman maids and matrons, guided by instinct and the example of the frail sisterhood, used silk effectively to enhance their appeal and their own innate desire for loveliness. Seneca, scolding, said: "I behold silken garments, if garments they can be called, which are a protection neither for the body nor for shame," and Solinus in echo remarked: "This is silk in which at first women, but now even men, have been led by their craving after luxury to *show* rather than *clothe* their bodies."

When men, too, began to decorate their garments with silk, the stern Roman senate ruled that silk was to be the exclusive property of women. But this rule was shattered when the sensual Emperor Caligula draped his throne after the manner of eastern potentates with silken curtains and added silk garments to his wardrobe. The epicurean Emperor Heliogabalus first shocked his court by appearing wholly clad in silk, and then impoverished that court by its frenzied attempt to emulate the imperial fashion. For silk was then so expensive that it was seldom used alone in a fabric, and the extravagance of silk garments was illustrated when Aurelian (273 A.D.) refused to buy a silk robe for his Empress on the grounds of its inordinate lavish costliness.

The demand at Rome pulsed back through Tyre or Berytus (Bierut) to Persia, India and China, and stimulated both the commerce in raw silk and its manufacture. This increased the supply of silk fabrics so that eventually ordinary well-to-do Romans could afford to purchase it, but nevertheless silk remained in the class of luxuries.

Silk at Byzantium.—It was not until about 550 A.D. that the western world learned what silk really was. At that time, the silk arriving overland at the imperial city of Byzantium—now Constantinople—was interrupted by the conquests of the maraud-

ing Turks in the Near East. Justinian, seated at Byzantium, had favored the Nestorian religionists. Perhaps out of gratitude for this imperial sanction where formerly they had suffered persecution, or maybe, as some authorities assert, because bribed by the selfish monarch, two Nestorian missionaries, who had become familiar with silk culture in India and China, brought several thousand silkworms' eggs concealed in their pilgrims' staffs to Justinian at Byzantium. This unusual transportation was possible because it required 34,000 eggs to weigh one ounce. The delighted ruler made the culture and manufacture of silk a royal monopoly and shut out, by confiscatory tariffs, the silk that might have entered Byzantium by way of Arabia, the alternative route for the one closed by the Turks. Justinian's policy brought a flood of riches to the royal treasury, but it so raised the price of silk that its use was limited to the most wealthy. The imperial monopoly was abrogated by Justinian's successor, with the result that silk culture as well as silk manufacture spread slowly in the colonies of Greece at the eastern end of the Mediterranean.

Silk in Italy.—Sericulture remained in the East until the 12th century, when Venice conquered Constantinople and transferred the silk industry to her island imperial seat; but meanwhile silk manufacture trickled westward both by way of Greece and through Africa in the train of the Saracens and Moors who, in the 10th and 11th centuries, carried the art to Spain and Sicily. When, in 1148, the Norman, Roger I, conquered Sicily he imported silk craftsmen from Corinth, Thebes, and Athens to carry on the trade of the ousted Moors at Palermo. Sericulture and silk manufacture in the 13th century spread slowly in Italy in the dominions of Venice, Genoa, Florence and Sicily.

It was from Italian workmen cozened into France, first at Marseilles and Tours, and then at Lyons, that sericulture, under the vigorous support of Henry IV of Navarre, was firmly rooted in France.

The English knew nothing of the culture of silkworms or the manufacture of silk until the French King Louis XIV, endeavoring to atone for youthful profligacy by aged piety, revoked the Edict of Nantes and so drove several hundred thousand Huguenots

from France. Among the fleeing Protestants were most of the people who understood both branches of the silk industry. They carried their knowledge to their sanctuaries in England, Switzerland, and Germany. In England only the manufacture of silk took root, for the economic and climatic environment of the British Isles was hostile to the domestication of the silkworm. Spitalfields (now part of London) and Coventry became recognized centers for the manufacture of silk.

Sericulture in Colonial America.—In accord with the mercantile theories of the time, the impossibility of raising silkworms in Britain caused the rulers to insist upon sericulture in the colonies at the same time that the colonies were forbidden to manufacture the silk they produced.

James VI of Scotland, who by inheritance became James I of England, was violently opposed to the tobacco industry of the infant colony in Virginia. At the same time he was just as stubbornly insistent that the new silk industry of Britain should thrive. He therefore, in 1619, ordered Virginia to abandon tobacco and raise silk, and in 1622 sent one John Bonell to Virginia as an instructor in silk culture. But regal pronouncements were no more effective against the tides of economics than against the rising of the sea. James, like Canute, could not command natural forces. Tobacco, fitting the frontier conditions of Virginia, thrived in spite of kingly disfavor, while sericulture, possible only in regions with a dense population of poverty-stricken people, was reluctantly prosecuted and feebly kept alive only as long as the bounty of 50 pounds of tobacco per pound of raw silk was paid. In Virginia, the bounty was withdrawn in 1660 and the languishing sericulture expired. At times by individuals it was temporarily reanimated, but vigor it never possessed, although one Cromwellian poet claimed that Virginian cocoons were as large as lemons.

Since the mulberry leaves on which the worms lived, and the worms themselves, were without difficulty raised in America, it took 300 years of bitter experience to prove that the first experiment in Virginia was prophetic.

After Virginia, the colony that made the most persistent effort

to provide raw silk was Georgia, workers and tools from France and Italy being imported for the instruction of natives. The culture reached its peak in Georgia in 1759, but the industry, though declining, continued until 1772. Probably as much as 20,000 pounds of cocoons were delivered to Savannah between 1758 and 1766, but scarcely 1,000 pounds were exported to England. At that time both France and Italy were producing more than one million pounds of raw silk.

To the north, sericulture was attempted in the Carolinas, New Jersey, Pennsylvania, upon Long Island, in Connecticut, Massachusetts, and New Hampshire. Among the leading men who sought to establish sericulture in New England was President Stiles of Yale. His diary from 1763 to 1790, now in the Yale Library, was full of contemporary lore concerning the propagation of mulberries and the care of silkworms. He was active in spreading this information and had a personal interest in the experiments on Long Island and in various villages in Connecticut.

Silk fabrics made from American silk were mentioned from time to time in the chronicles of England in the colonial period. Special comment appeared when some prominent man or woman was given or wore an article of dress woven from American raw silk. It was said that the silk coronation robe of Charles II was of American origin, and Caroline, Queen, wife and conscience of George II, was supposed to have had a robe made from American silk. The famous Mrs. Pinckney of South Carolina had three silk gowns whose material was produced in her beloved colony. Officials and merchants in America from time to time boasted of waistcoats whose silk was raised locally. But these cases all had news value because they were unusual. Despite such encouragement from folks in exalted positions the humble rural population were unmoved. Those few who did try to rear silkworms soon abandoned the trial for the commercial results were discouraging.

Sericulture in the States.—Despite the lesson taught by the colonies, new generations in the youthful states ignored the precepts of their fathers and in their turn enthused over the prospects that glittered in sericulture. By that time the South was finding riches in cotton as well as tobacco, so had little inclination to

gamble with raw silk. But New England, the Middle States, and, strangely enough, the recently opened territories in Kentucky, Tennessee, and Ohio plunged into the production of silk.

The most pronounced and widespread mania for raw silk occurred between 1826 and 1844. Until then the usual food for silkworms had been the leaves of the white mulberry, but at that time the quick-growing Chinese mulberry (*morus multicaulis*) was introduced in America with results akin to the first importation of merino sheep. Apparently everybody was crazy to get rich at once by planting the new variety of mulberry. There was not so much intent to raise silkworms as to produce the trees upon which the worms fed. The nurserymen expected to sell cuttings to a people who, they supposed, were eagerly awaiting the trees in order to engage in rearing the worms. They convinced themselves that the lack of worms was due solely to a paucity of food supply, a deficit which they expected to relieve.

Societies of tree growers were organized, periodicals and books were published imparting information and encouragement to the growers, and public funds were appropriated to secure the cuttings for local farmers. At the height of the folly the cuttings commanded a price greater than any silk that could be produced from them. From \$5 a hundred the price of cuttings jumped to \$500. As exhaustion follows fever, so disaster swiftly succeeds unwarranted exploitation. First, the national panic of 1837 shook all enterprises so that those that were insecure crashed; then it was found that the market for the final sale of trees was narrow and that the few who did endeavor to rear silkworms preferred the white mulberry, which gave better results than the Chinese mulberry; finally, in 1844, an epidemic blight fatally attacked all kinds of mulberry trees that had survived an extraordinarily severe winter in 1839, when most of the Chinese mulberry trees perished. In the forties some 60,000 pounds of silk was produced; by 1844 the amount reached 400,000 pounds, but by 1850 the output shrank to 14,000 pounds.

Cuttings bought at \$500 a hundred were disposed of for pea brush at \$1 a hundred.

This expensive tutelage convinced the eastern farmers that

silk culture was not for them, but the nation as a whole had not yet accepted the interdiction.

Consequently, in 1861 a French migrant to California once again sought to establish silk culture in America. Raw silk would have been an admirable product for California, for it easily could have borne the expense of transportation to the East; at that time California had only two salable commodities, wheat and hides. The mulberry trees planted at the instigation of the French promoter flourished and the worms did fairly well except in the winter. So for a time the area around Santa Barbara added a Spanish industry to its Spanish environment. There were at least 10,000 trees set out and as many as 300,000 cocoons gathered, an amount sufficient to make 100 pounds of silk. But despite the similarity of that section of California to Spain, its silk culture withered and disappeared.

Once more, in the late seventies, the usually wise Federal Department of Agriculture endeavored to promote sericulture in Kansas, Utah, California and Louisiana. The result was dismal.

As late as 1901 the United States Department of Agriculture attempted to persuade southern negroes that silk culture would emancipate them from the debts that had accumulated from the system of exclusive cropping of cotton. But the negroes preferred the easy intermittent work on cotton to the severe continuous toil with raw silk.

During the last quarter century no individual nor official has urged Americans to produce their own silk. Of the 35 million pounds used by our manufacturers in 1925, every ounce was imported.

Why Sericulture is Uneconomical in the United States.—The ban upon American sericulture is not agricultural but economic. Our soil and climate have proved well fitted to the production of mulberry trees and the worms, when granted sufficient care, thrive in this country.

But the labor involved in sericulture is unbelievable in its exactions. At the time the worms hatch from the eggs they eat prodigiously. The sound made by hundreds of them feeding in a

building resembles that produced by a stiff breeze in a full leafed cottonwood tree. During this feeding period the worms not only must be provided with quantities of picked leaves but, since they are sensitive and delicate, they must be guarded against sudden changes of temperature and loud noises. Moreover, being domesticated and reared artificially, they are peculiarly liable to diseases which flare into mortal epidemics. Throughout the brief life span of the worm, therefore, they are watched and cared for during the whole 24 hours of each day.

The reeling of the silk from the cocoons is another painstaking job and one demanding unusual deftness. After thirty centuries of experience the Chinese can reel but two pounds of silk per week. Nearly all the work is manual and no machinery has been devised that can feel, see and think about the constant variations encountered in the progress of the task. Unless extreme caution is used, the workers can spoil and waste more silk than they reel. More labor employed for more hours and involving more people goes into a pair of chiffon hose—silk to the top—than is necessary to construct a Los Angeles office building.

Although Americans never approached the skill acquired by the Chinese and Japanese during many centuries, they nevertheless did learn the above processes. But no Americans at any time, from Virginia whites in 1660 to Carolina negroes in 1900, could compete with the Orientals in the wages accepted for the meticulous tasks. The lowest wages ever paid in America were ten to twenty-five times the wages accepted by the Oriental silk growers, and ten times those paid in Italy. At the wages paid American common labor in 1927 the hosiery just mentioned would cost about as much as the office building. This is the reason America never has succeeded in sericulture, and why we are willing to pay millions of dollars per year to others to raise the silk we manufacture. The fact that our raw silk travels half round the world to our factories is inconsequential, for the freight charges, high as they are, are incidental in proportion to the value of the material. A single bale of silk may be worth a thousand dollars, and one trainload may exceed two million dollars in value. Under these conditions Americans cannot produce raw silk.

Steps in Silk Manufacture.—Raw silk is in reality a partly manufactured product. The actual spinning is done by the worm, for its cocoon is one continuous thread about 4,000 yards long. To make the raw silk of commerce the threads of cocoons are carefully unwound and disentangled. Only part of the cocoon—about 300 yards—is most valuable, for its outermost and center sections are either too fragile and broken or too compacted except for “spun silk.” Ordinarily the threads from six cocoons are joined, but as few as three and as many as twelve may be united. The product thus joined, coiled in skeins in China and Japan is the raw silk which we import.

Although the raw material is partly manufactured when it arrives at a factory, the first process is similar to spinning in other textile fibers. This process, called “throwing”—from the Saxon word “thrawan,” meaning “to twist”—comprises six operations for the warp yarn and five for the weft, when the yarns are to be woven, and a different set if the yarns are prepared for sewing purposes. All the operations in a “throwing mill” may be summarized as cleaning, doubling and twisting. They were originally hand operations but lent themselves to machine production.

Weaving, which with every textile is a skilled job, was in the case of silk a particularly deft task calling for the utmost care. Because the yarns were delicate and small—yet with the tensile strength of iron—numerous to the inch of cloth made, and variable in dimensions on account of their insect origin, it was impossible, for a long period of years, to devise a practical power loom. Hand looms were common, even in machine-loving America, until 1905.

These technological details had an important bearing upon the history of silk manufacture in America.

First Silk Mills in America.—In the colonial period all silk manufactured in America was a household product. After the Revolution the leading state in what eventually proved abortive efforts to produce raw silk was Connecticut. The valleys of the Connecticut and Willimantic rivers, with their northward extensions into Massachusetts, were the principal centers. In this area of raw material the first silk mills appeared.

Rodney and Horatio Hanks, in a tiny building 12 feet by 12 feet, located at Mansfield, Connecticut, started the first silk factory in 1810. These men with three others constructed, in 1814, a larger mill at Gurleyville, five miles from the first. Manufacture in these mills, and a third at Mansfield, was carried on desultorily until 1828. A more ambitious project was started at Mansfield in 1827, when the Mansfield Silk Company was organized by six men, each of whom was later connected with other pioneer silk mills. The Mansfield Silk Company benefited from British advice and assistance and had a power reel for winding skeins. Unfortunately the promoters were caught by the craze for sericulture, so that their manufacturing was abandoned in 1839. However, since this company operated for twelve years, it is credited as the first successful American venture in silk manufacture.

Before the Mansfield company expired another company began operations at Florence, near Northampton, Massachusetts. A small grist mill, then a century old and known locally as the "Oil Mill," was occupied for silk manufacture in 1832, under the direction of Samuel Whitmarsh. Two years later, when New York investors were induced to help the business, a new brick mill was erected and the company named The New York and Northampton Silk Company. This company, too, entered upon sericulture and crashed in 1839.

Some of the backers in the above mentioned enterprises formed the Nonatuck Silk Company at Florence, taking the Indian name for the region. Influenced by the wave of social reform then sweeping the country, the founders intended to make Florence a communistic colony dividing its time between agriculture, sericulture and silk manufacture; but this aim was abandoned in the formative stages of the Nonatuck Company. This organization is today a large and flourishing one.

From Mansfield the silk manufacturing industry sprang up at various points in the Willimantic Valley, including the town of Willimantic and the city of New London. From Florence the industry followed the Connecticut River southward to Northampton, Holyoke, Springfield, Windsor Locks, Hartford, South Manchester and Middletown. The Cheney Brothers' mill established at South Manchester, and started in 1838, grew to be the largest

silk manufacturing concern in the United States. Another venture to attain significance was that of William Skinner, whose mills were at Haydenville and Holyoke, and noted for the production of satin.

At the same time William H. Horstmann, an immigrant from Cassel, Germany, who had learned the trade in France, was laying the foundations of silk manufacture in Philadelphia. He and his sons conducted one of the most successful of all the silk mills started before the Civil War.

Sewing Silk and Machine Twist.—The principal product of these early mills was sewing silk. To manufacture it required the “throwing” processes and an operation which gave enough twist to the material to hold it together for sewing purposes. No extraordinary skill was called for in manufacture, and machinery was soon developed to aid the workers. Moreover, sewing silk could be made from the lower grades of raw material. What little raw silk we produced was mostly of these grades, and so also was that which we imported. The only sources of raw materials then were France or Italy, both of which kept the fine grades of raw silk for their own most beautiful fabrics for which they alone had the labor.

The sewing machine invented by Elias Howe was a boon to the silk manufacturers, for it increased their business both in the households and in the manufacturing industries that installed power sewing machines. Examples in point were the clothing, shoe and glove industries. However, at the inception of the sewing machine the sewing silk then made proved a bane because it unravelled. Investigation by the silk manufacturers revealed that for machine use, in contrast with that threaded through the housewife’s needle, the silk had to be twisted harder, in the reverse direction, and of three ply instead of two ply strands. For machines, therefore, a new product was created which was called “machine twist,” to distinguish it from “sewing silk,” which was continued in production.

Sewing silk at first was put up in skeins and peddled from house to house, the wives buying it for dressmaking and embroidery. Eventually, along with “machine twist,” it was sold in

stores. The machine twist also was sold directly to manufacturers and to dealers in manufacturers' supplies.

The machine twist business soon outran the older sewing silk and became the mainstay of expansion and profits. In some instances the manufacturers of sewing silk and machine twist engaged in the production of braid, trimmings and even ribbon. But they did so to utilize portions or grades of raw silk that could not go into the sewing materials, or to balance the operation of the factory. While braids and trimmings were manufactured with considerable success, the production of ribbons for a long time was a losing speculation.

Since sewing silk and machine twist were capable of mass output in standardized brands by machine production, our American mills readily captured the domestic market. By 1876 our makers feared no foreign rival, and after that date admitted no equal in the world. Indeed, we not only served our own market without a foreign competitor but we exported our spooled silk thread to other countries including France and Italy.

This branch of the silk business grew out of the original mills in New England and Philadelphia, and to this day the principal production is in those places.

Failure to Make Woven Silk.—From time to time those engaged in American silk manufacture endeavored to produce woven goods. While they met with some slight success in narrow silks, such as braids and ribbons, the efforts to make broad silks (technically all goods over twelve inches wide) were a dismal failure. The census of 1850 listed but two silk weaving mills, which together had a capital of \$5,000 and employed eight people.

Weaving broad silk was a handicraft of extraordinary skill and we had neither the workers nor the hand looms to pursue this calling. To make the goods, also, the finest raw silk was required and neither Italy nor France had an excess over their own demands. Finally broad silk was a luxury because of the great cost of the raw material and the expense of manufacture. Therefore clothing made from it was treasured, worn only on special occasions and listed among legacies. Under these circumstances there

was no quantitative demand for broad silks. Like coffins, one purchase sufficed.

Changes in Fundamental Conditions.—After 1860 each of the factors which up to that time had barred us from manufacturing broad silk was altered in our favor. A misguided British government entered into a reciprocity treaty with France whereby French silk entered Britain without duty. This prostrated the British silk industry and drove to America not only many of the skilled throwsters and weavers but also the managers and capitalists.

At the same time the storehouse of silk in the Orient was unlocked. The first step was the agreement between Japan and Commodore Perry in 1854 to permit commercial relations with the world. To be sure, certain Chinese ports had been open to our trade since the beginning of our government, even though Japan had been closed to all foreigners from the days Spanish galleons wallowed from Manila to South America. But the Chinese emperors rigidly restrained this commerce for the Chinese had little incentive to increase the foreign trade or listen to advice as to ways to make their wares more acceptable to the Occident. Once the barriers around Japan were pierced that country sprang to meet the commercial desires of the West. So Japan sold her own silk and China's as well. She changed her practices in reeling raw silk to fit the manufacturing requirements of Europe and America. Finally, the Japanese government controlled all silk export and refused to permit shipment of that which did not come to specified grade.

This Oriental raw silk we did not buy round-about through Europe. In 1869 the Union Pacific and Central Pacific Railroads linked the Atlantic States with San Francisco. Later railroads connected Seattle with New York. With these railroads spanning the continent, raw silk from Japan was sent directly to the manufacturers on the Atlantic seaboard. As a result, these industrialists had their choice of grades of raw silk in quantities of any amount.

Our people by 1850 had virtually convinced themselves that they could not grow raw silk. Congress thereupon changed its

policy toward the taxation of imported raw silk. From 1789 to 1857 raw silk paid a sizeable duty but the impost was removed on European raw silk in the latter year, and upon Oriental raw silk in 1863. From that date all raw silk has entered this country free of charge. On the contrary, silk goods, which until 1861 had been lightly taxed when entering our boundaries, were selected for a deliberately discriminatory duty in 1864, when a 60% ad valorem impost was fixed. This was retained until 1883, when it was lowered slightly, the lower rate continuing until 1913, when the rate was fixed at 45% ad valorem. By these important changes raw material came to our manufacturers free of imposts while competing manufactured silks were obstructed by an almost prohibitive tax.

Response to Changed Conditions.—The first branch of weaving to respond to the changed conditions was that which produced ribbons. At the time of the Civil War ribbons were fashionable for dress trimmings, so that the demand was unusual. When imported ribbons were interrupted by the vicissitudes of war, importers in desperation turned to American silk mills for supplies. The silk manufacturers were willing to speculate in filling the gaps in importations and surprised themselves and the ribbon dealers by the promptness with which orders were filled, and the quality of the product. The ranks of silk makers were swelled at this time by some former manufacturers of cotton whose raw material was rendered scarce and high-priced by the war. These newcomers to the silk industry took up the manufacture of ribbons. They and the established silk makers imported ribbon machinery from England, France, Switzerland and Germany.

The success with narrow silks encouraged further experiment in producing broad silk. With British craftsmen at hand and with the impetus given in 1866, when P. G. Givernaud, his three sons, and sixty weavers, removed from Lyons, France to West Hoboken, bringing with them the latest French and Swiss machinery, the broad silk business bloomed. By 1870 the business was firmly established so that from that date onward its history is one of expansion.

Rise of Paterson, New Jersey.—Just as the sewing silk and machine twist branch of silk manufacture was localized in New England, so, too, the new silk weaving after the Civil War centered at Paterson, New Jersey.

The story of silk manufacture at Paterson begins long before the Civil War and is tied to the early ventures in New England. Christopher Colt, the brother of Samuel, who invented the revolver, was president of the Connecticut Silk Manufacturing Company at Hartford. Christopher's son of the same name, wishing to enter silk manufacture for himself, prevailed upon his uncle Samuel to grant the junior Christopher the use of the fourth floor in Samuel's pistol factory at Paterson. There, for three months the young man manufactured silk, but ran into difficulties in the hectic period of the late thirties. John Ryle, of Macclesfield, England, an experienced silk maker, in visiting the New England silk mills, met the Colts and G. Murray, another Yankee silk maker. Ryle persuaded Murray to buy young Colt's silk business at Paterson, the sale price being \$3,200. Ryle managed the enterprise for Murray for three years after 1840, and then was taken into partnership. After another three years of successful operation, Ryle bought Murray's share and also purchased the whole of Samuel Colt's mill in Paterson.

Ryle's business grew slowly and surely so that in 1854 he built a new mill two stories high and with 15,000 feet of floor space, then the largest silk factory in America. With his sons Ryle seized the opportunity offered at the time of the Civil War and began to make broad silks, although in this branch full success did not come to the company until after 1872. By that time the Ryles were not only leaders in Paterson, but among the foremost silk manufacturers in the country.

But the Ryle business at Paterson had no imitators until 1852, when John C. Benson opened a combination silk and cotton factory. Two years later and again in 1856, a throwing silk concern entered Paterson but the second one stayed but a short time.

It was not until 1861 that the silk industry began to boom in Paterson. In that year a former cotton enterprise was remodelled for making silk and took the name, the Phoenix Silk Manufacturing Company. In 1864 the Dale Manufacturing Company

put up a mill that cost half a million dollars, and in the same year J. H. Booth and Company began operations. In 1886 three more mills and two dye-houses were added to Paterson's silk industry and in 1867 still another large factory started business.

From that time new enterprises accumulated so rapidly that we cannot give them individual mention. By 1875 there were 32 companies making silk in Paterson and five dye-houses serving the former. Some 8,000 employes were engaged, of whom 75% were females. When the census was taken in 1879 Paterson had 77 silk factories, 10 dye-houses and 15 firms engaged in furnishing silk manufacturers' supplies.

In 1926 Paterson produced from 20% to 25% of all the broad silk made in the United States. To this might be added the production in the neighboring cities and towns, which would bring the broad silk output of northern New Jersey to a third of the national production.

Why Paterson Leads.—Paterson attained this remarkable command of the silk industry for many reasons. First among them was her proximity to the leading market in New York. When style became a vital factor in silk manufacture this nearness to buyers with whom consultation was easy was a source of unusual strength to the New Jersey silk makers. The second most important cause for Paterson's growth was the character of the industries it possessed prior to the introduction of silk. The city had been started by Alexander Hamilton and his associates as a cotton mill center but it had acquired the most prestige as a maker of heavy machinery, including locomotives. The silk mills drew labor from the cotton factories because the work was less tedious, confining or dusty. It fed upon the labor supply created by the metal working plants because these employed men alone; the female relatives of these men rejoiced at the opportunity to do the dextrous wholesome tasks in the silk mills.

The power supplied by the 72-foot drop in the Passaic River at Paterson was an incentive and aid because it furnished the clean energy to drive the silk machinery, cleanliness being essential for the delicate luxurious product. Moreover, large quantities of clean water were used in the processes of silk manufacture.

Mills at Paterson not able to tap the water power were consoled with the clean anthracite coal brought to their doors by the Morris and Essex Canal, which passed through Paterson. Later the railroads which competed with the canal had to set low rates for coal because of the potential competition of the waterway. Finally, after the silk business was firmly established in Paterson, new concerns found the city advantageous because the market was assured, trained labor available and subsidiary enterprises at hand (dye-houses, silk machinery makers, and silk mill supply houses), so that specialized small-scale production was possible.

Throwsters in Pennsylvania.—Compared with weaving the “throwing” of silk is simpler, capable of fuller use of machinery and more regular in operation. The matter of regularity is understandable when attention is called to the fact that the product of the “throwster” is a raw material which may be used by makers of sewing silk, machine twist, narrow goods, broad silks and knit goods. If one of these outlets was closed the others were open. On the contrary, woven silk is a final product calling for a high degree of skill in its manufacture and dependent upon the whim of fashion for its salability.

Consequently “throwing” can be separated from twisting, weaving, or knitting. Indeed, it is more economical as a rule for the finishers to purchase their thrown silk from specialists in throwing. Throwsters, therefore, are at liberty to seek the location where manufacture is most economical.

While raw materials constitute the main item of expense in “throwing,” accounting for about 60% of the total, the charge for direct labor is the principal residual cost. It is advantageous, then, to secure the cheapest labor.

Throwsters found this labor in the anthracite coal mining and cement manufacturing towns of Pennsylvania. Since the miners and cement makers were men, no wage employment was open to women until the silk throwsters moved into the cities. With abundance of labor and few competitive demands for it, wages were low and hours long in eastern Pennsylvania. For example, in the strike of 1907 it was found that for a certain throwing task the wages at Paterson were nine dollars for a week of 55 hours, and

\$3.50 at Scranton for a week of 58½ hours. Under such conditions the "throwing silk" branch moved into Pennsylvania to such an extent that in value of silk production this state exceeded New Jersey.

Broad Silk Follows.—When Pennsylvania had acquired leadership in silk throwing, manufacturers of narrow and broad silks came to the state. The products of these mills were most often the staples of their branch, for the makers of novelties and fashion articles found it advantageous to remain nearer their market. The motives for moving the silk weaving into Pennsylvania were desire to be next the throwsters and to escape dealings with the United Textile Workers, the Amalgamated Textile Workers and the Industrial Workers of the World. These labor organizations were stronger in Paterson, Hoboken and Weehawken than in the Pennsylvania towns where silk was manufactured.

Before long, the production of silk in linear yardage and the installation of looms in Pennsylvania were greater than in New Jersey. So also, this was true as regarded the total values of silk and the total number of weavers employed in broad silk output. In all four of these indices Pennsylvania led New Jersey by about 10%. Nevertheless, no city in Pennsylvania could compare with Paterson, which retained leadership of the silk industry.

Spun Silk.—As we have said, in the reeling of raw silk from the cocoons a great deal of material was unfit for raw material for throwsters. Likewise, in the throwing mills and weave sheds small shreds of silk were thrown out by the operations. Until 1857 all this valuable material was useless. But beginning in that year these short, broken silk fibers were treated much as flax fibers were in the production of linen. That is, the silk was carded, combed and spun in the common manner so that a serviceable silk yarn was produced. To distinguish this commodity from the long fibers drawn from the cocoon the former was named "spun silk" and the latter "reeled and thrown silk."

Spun silk may be manufactured into all the articles made from reeled and thrown silk. But since the fibers are short the spun yarn is weaker and lacks the sheen of the reeled and thrown silk.

Therefore, spun silk was used for the cheaper grades of silk goods and fabrics. It also was employed as a weft yarn by other textile industries such as cotton and wool to yield a mixed goods in which the beauty of the silk was an advantage, yet without incurring the excessive cost of goods mixed with reeled and thrown silk. The machinery that entered the spun silk division has been improved to such an extent that today only an infinitesimal amount of silk is "wasted" in the sense that it is useless.

Weighting.—To meet the competition of cheaper spun silk fabrics and to offset the loss (20% to 25%) in the boiling off of natural gums before dyeing the goods made from reeled and thrown silk, these were "weighted." That is, the dyer took advantage of the absorptive qualities of silk and gave it a bath of sugar, tannin or tin (this dissolved in acid). The two first named were abandoned because the silk treated with them would not take delicate shades in dyeing. So most weighting was done with dissolved tin, although other metals also were used. Silk thus burdened was weakened, but it was also cheapened. Used within reason, weighting was legitimate if applied to goods that were intended for temporary use and sold at a reduced price. The extent to which weighting may go is manifested by the fact that 16 ounces of silk may lose 4 ounces by boiling off the gum and other matters, and then be fattened by weighting to anywhere from 40 ounces up to 60 ounces. Moreover, if the gum is not boiled off, still greater weighting may be done because the gum also absorbs the metallic substances. Thus, 16 ounces of gummy silk may be weighted to 120 ounces. Spun silk is capable of the greatest weighting, for 16 ounces of it may be made to absorb 150 ounces of adulterant.

The abandonment of the custom of making silk dresses heir-looms and the quick shift in styles for women's clothes attracted women to cheaper prices per yard for silk fabrics. That the cheaper silk was perishable was immaterial. These circumstances tempted silk manufacturers to extraordinary lengths in weighting silks and penalized the maker who withstood the temptation. Weighting then passed beyond its legitimate use and brought demoralization to the industry. Trade standards had to be devised

to control weighting. Also manufacturers who did not weight their fabrics had to go over the heads of wholesalers and retailers to reach the consumers by national advertising.

Scale of Operations.—Although American silk manufacturers after the Civil War jumped into first place among the silk makers of the world, having a large, wealthy, domestic market at their command, nevertheless the silk industry is not one that Americans have pushed into large-scale production. There are some large plants for the production of sewing silk and machine twist, and there are a few big throwing enterprises. So, too, there are five or six silk weavers that have installed as many as 5,000 looms. But most silk mills, in whatever branch they specialize, are relatively small-scale affairs. A half of the broad silk factories of Paterson claim less than 100 looms and there are many that have as few as ten looms. The reason for this condition is the paucity of silk staples. To be sure, sewing silk and machine twist are practically standardized, and it is in this branch that large-scale operation is most common. At the other extreme, woven silk is nearly all produced to catch a prevailing mode, and styles are as whimsical as the women for whom they are created. No business that depends on style can use the principle of mass production.

Yet a kind of large scale organization does exist in the silk industry, for there are several groups of investors who own a "chain" of small mills. Just as the Atlantic and Pacific Tea Company and the Liggett Drug Stores are powerful central organizations with economies in purchases, management and sales, notwithstanding that the units are scattered and small, so, too, do the silk mill "chains" enjoy the advantages of large-scale organization, despite small individual factories. The chain mills can offer a diversified line of goods even including novelties, produced in specialized units operated on a small scale.

Silk Association of America.—The various branches of the American silk industry came together for a common purpose for the first time in order to prepare for the Exposition in 1869. This united action was so salutary that a National Association of Silk

Manufacturers was organized in the exposition year. Three years later the details of the organization were changed and the new name, Silk Association of America, was adopted. Ever since that time this has been a powerful force in the industry and one of the leading trade associations in the country.

Status of the Silk Industry.—The American silk industry has not reached maturity, for, despite the fact that America is the world's greatest buyer of silk, our consumption continues to mount with our national wealth. Between 1914 and 1925 the number of establishments increased 83%, with an absolute number of 1,659 in the latter year. That the product of the industry is worth almost a billion dollars a year is not startling when the value of the raw material is considered, but this billion figure becomes significant when one appreciates that the value of the raw material is only half the value of the finished product.

Technical efficiency in this growing industry is proven by the disappearance of the hand loom, the approximate doubling of power looms per weaver and yards per weaver, and the 50% increase in product per loom. Because of technical efficiency our imports of manufactured silk are slightly less than in 1880, while our production has jumped from a value of 7 million dollars in 1880 to 808 million in 1925. The only silk we do not manufacture is the highest grade of style fabrics, in which low-priced but skilled hand labor is a factor. Since it is a young industry and still growing, silk manufacture offers attractive opportunities.

Rayon.—A product so costly and yet so popular as silk was sure to have imitations and substitutes. In a former generation mercerized cotton seemed to make the strongest bid as a silk substitute, but in the present generation artificial silk, recently named Rayon, has swept to the front. Since the rayon industry was discussed in Chapter XV, we need say here that just as the silk manufacturers use millions of pounds of cotton, woolen, worsted and mohair yarns, so also, they buy millions of pounds of rayon. Indeed, cotton and rayon are purchased in equal amounts, about 15 million pounds per year. However important the goods that are manufactured with a mixture of silk with other textile yarns

may be, three-fourths of the products of our silk mills still are all-silk fabrics. Rayon is one of the half dozen yarns mixed with silk in the remaining fourth of production. All of our textiles that once were distinct are now more or less interdependent.

That rayon completely will displace silk is unthinkable. Rayon is really a new textile fiber with merits of its own and a field of usefulness in which it will be unchallenged. Its entrance into industry has caused a readjustment in all the textile industries including silk. Rayon may replace silk in all the uses in which the lowest grades of silk have been employed, and may invade some of the medium grade fields now occupied by silk. But the highest qualities of silk goods are above the power of any substitute to dislodge. Silk is to rayon what a polo horse is to a cow pony; neither can do the work of the other and each is valuable in its sphere—but the polo horse is the aristocrat of horses. So, too, silk is the supreme textile.

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CHAPTER XVIII

LEATHER

Leathers and Tanning Agents.—To the lover of the spectacular the leather industry offers rare satisfaction, for in seeking suitable raw materials for leather men have explored the animal, vegetable and mineral kingdoms and have subjected to treatment the hides or skins of beasts, birds and fish. As tanning agents the brains, oils and fats of animals have been used; the woods, barks, leaves, fruits, roots and even the larvae of parasitic insects or the diseased portions of plants have been made to save hides from decay by fixing their gelatin content; and minerals, from alum or iron to common salt, have been tested as preservatives. The hides or skins of all the common domestic animals have formed the basis for leather, while the hunt has been extended also into the wilds, and the hides of elephants and buffalo or skins of antelope, deer, kangaroo and even rabbits have been brought back to the tannery. The ocean, too, has furnished its share to the industry in the skins of seals, porpoises, alruses, whales and sharks, and fresh-water ponds have been dragged to give up their humble frogs in order that the leather business should not lack for materials. Lizards, crocodiles, alligators and snakes have at times contributed supplies to the tanner's art. Even the birds have suffered the same fate, for ostrich and swan-skin leathers have not been unknown, and during the Elizabethan period leather from chicken skin was quite a favorite for gloves or beauty-masks worn at night—much as rubber masks now are sometimes employed—to remove wrinkles or reduce double chins. Man's own skin has been manufactured into leather.

From reptiles to man, from roots to fruits, well-nigh every living thing has at some time in some place been made to fill the need for leather. Savages and civilized men alike have found in leather the material most readily adaptable to a wide variety of

uses ranging from clothing or house furnishings to tools, weapons and musical instruments. Since leather has been essential everywhere to human beings in all stages of advancement, it has been manufactured from the materials closest at hand; this accounts for the amazing variety of substances employed.

Tawing and Tanning.—While hides in the natural state have considerable durability if kept dry, they can be made to last longer by being changed into leather. Hides contain fibers which deteriorate but slowly under the ordinary agencies of decay; and gelatin which rots quickly if not changed in form. Long ago savages in the hunting or fishing stages of evolution discovered that hides could be changed to more permanent usefulness if they were treated with the brains or fat of the animals from which they were taken. Certain oils were found to have the same effect. Although savages were ignorant of the reason why leather was better than the untreated hide, they were well aware of the fact, and were not only closely observant of the causes which produced the effects they wished but were proficient in the art of manufacturing useful and beautiful leathers. The leather made by American Indians, for example, has never been bettered by white Americans, regardless of the white man's advantages in technological knowledge. Converting skins to leather by means of fats, oil, albumens or alum has been given the technical name "tawing." This method is probably older than the now more prevalent one of "tanning," in which the gelatinous content of hides or skins is transformed by an infusion of tannin derived from certain vegetable sources.

Chamois is a well-known leather that formerly was made exclusively by impregnating skins with oil. The French glove leather was made by a mixture of alum, salt, wheat flour and the yolks of eggs, the latter comprising the bulk of the materials. Thousands of dozens of eggs per day were used by some of the French tawing works. American "morocco," a leather formerly popular for shoe uppers, was manufactured by the tawing process.

Notwithstanding that tawed leathers have had an age-long use, tanned leather, almost equally ancient, has predominated among white Americans. The tannin has been derived from the

bark of hemlock, oak and chestnut and, to some extent, from sumac.

Curriery.—Tanned leather was stiff and harsh so that before it could be used it passed into the hands of the currier, the craftsman who finished the leather. The currier treated the tanned leather with oils and other substances, which softened, preserved and colored the leather. The currier worked the substances into the leather and the wrinkles out of it by brushing, scraping and rolling with hand implements. In Britain, the curriers formed a distinct group separate from the tanners. In America, the colonies by legal enactments tried to keep the customary trade lines established between tanners, curriers and leather workers, such as shoemakers, but these efforts failed. Our communities were not large enough to warrant such a fine subdivision of labor, either on the side of market or in numbers of artisans. Consequently, we kept the trade names and recognized the limits of the processes, but leather workers made any combination of the arts they chose.

Colonial Leather Manufacture.—Leather manufacture began with the first generation of settlers in each of the colonies. In accord with the policy of government supervision of industry, Virginia, in 1661, required each county to provide for at least one tanner, currier and shoemaker, while New York, in 1676, granted a monopoly to two tanners. The colonies in their formative years also forbade the export of hides in order to encourage tanning, and prohibited the export of leather in order to aid shoemakers.

The tanning industry took such instant hold in all the colonies that after the first few years there was little reason for legislation to foster it. Most of the colonial legislation in reference to the leather industries was, therefore, regulatory rather than promotional; it was concerned with quality more than quantity.

Near the coast the manufacture of leather by households soon gave way to tanners specialized in the business. For although almost any pioneer could manufacture leather, it took a skilled man to produce good leather. It is believed that the earliest tan-

nery to operate a business separate from the household was started in 1630 at Lynn, Massachusetts, by Francis Ingalls. It was only in the back country settlements that household production of leather continued for any length of time. The retreat of the back-country westward, however, kept household tanning in existence for a couple of hundred years longer.

Colonial Tanneries.—The equipment of the professional tanner was crude. It comprised a series of vats sunk in the ground near a stream. The hides were moved from one vat to another for softening, dehairing, defleshing and tanning. The tan vat was filled with alternate layers of bark and hides, the whole covered with water, which leached the tannin from the bark, the hides absorbing it from the water. From time to time, the tanner turned the hides so as to insure even impregnation, and at the proper time removed the hides to other vats for varying strengths of tan liquor. The process took almost a year's time and the tanner's skill in manipulating the hides in the vats determined success or failure. The senses of sight and touch were his guides. Few, if any, of the vats were under cover, and when protection was provided it was merely an open-sided shed.

The bark was ground with wooden and stone wheels, the power being furnished by man, beast, or water. In the settled areas several tanners sometimes cooperated in the ownership and operation of bark mills. Bark mills, too, were individual enterprises separate from the tanners. The first bark mill was probably installed as early as 1661.

The hides and skins came to the tanner from the farm and from trappers. The tanner sometimes worked on commission, but since the process was a long one, he more often purchased the raw material either for cash or by barter for finished leather. The price of colonial leather ranged from 10 to 17 cents a pound.

Although all the colonies had numerous local tanneries, there was some slight regional specialization which gave rise to inter-colonial trade. New England tanned mostly with hemlock bark, while the middle and southern colonies made greater use of oak bark. Hence, the New England leather was generally lighter than that further south which resulted in interchange. This

specialization and resultant commerce were not carried to extreme, for all sections made all weights of leather, and used hemlock, oak and chestnut for tanning. One of the largest colonial tanneries was located at Trenton, New Jersey. In 1778 it had 64 vats, and besides the tanning, conducted the currier's arts, had a department for dressing skins and another for the manufacture of leather breeches.

It was the wealth of resource in the trees whose bark was useful for tanning that spread the industry so rapidly and universally through the colonies. Indeed, tanning grew more rapidly in all the colonies except Pennsylvania than the manufactures that used leather as a raw material. After we gained our independence the tanners, in 1792, petitioned Congress to forbid the exportation of tan bark, an action which indicated that the tanners fully appreciated the special favor our forest resource conferred.

✕ **Tanneries After Revolution.**—Tanning did not share with cotton, wool and iron in the industrial revolution that began in the United States after our two wars with Great Britain. Tanning was changed but slightly from colonial methods until about the time of the Civil War. In all the first half of the 19th century the principal factor in tanning was an adequate supply of tan bark.

Although bark is relatively light in weight it is bulky, difficult to handle and depreciates rapidly in quality and quantity if moved any great distance. It shatters, and the tannin content is leached if the bark is exposed. Because of its bulk, bark cannot be stored cheaply where high land values prevail. Bark, therefore, never has been transported far from forests.

Hides present an entirely different transportation problem. They can be preserved by simple drying in the sun, by dry salt, or by pickling in brine. When preserved, their rate of depreciation is much slower than that of most other materials. They can be carried over the roughest roads by the crudest means. Their value is so high in proportion to their bulk that they can profitably be carried all the way around the world. As a result, they always have been a great trading asset for economically retarded nations,

or countries difficult of access. Hides have been brought together from the interior of Russia at the annual fair at Nijni Novgorod, 275 miles from Moscow, and goat skins from the heart of China have been collected at the ports of Shanghai and Hong Kong. Likewise, the remote eastern front of the Andes kept in touch with the outside world through packs of hides toilsomely carried over the mountains to the nearest western ports. From South Africa, inland Portugal, upland Spain, and mountainous India, hides have trickled into the side streams of trade and finally reached the great floodgates of commerce. When California belonged to Mexico one of her principal exports to the United States was hides carried around Cape Horn to Massachusetts.

† **Location of Tanneries.**—Since tan bark and hides seldom have been found in sufficient quantities in the same locality one or the other had to be moved to the point of leather manufacture. The transportation factors determined that it was hides that should journey. Hence, until the Civil War our tanneries hugged the forests.

The large market for leather among the New England shoe manufacturers made tanneries most numerous in that area. But waning supplies of bark in New England caused the tanning industry to expand westward and southward. The hardwood forest region south from New York through Pennsylvania to Tennessee and west to eastern Ohio and Indiana furnished the greatest abundance of oak and chestnut bark. Upon this resource tanners fastened.

Our country was so little able to provide the hides and skins our tanners used that these were admitted free of duty until 1842 and lightly taxed even then. About 40% of our tanners' raw material normally was imported. For the domestic supply there was no central market, for all cattle and sheep were slaughtered at the point of consumption. There was no reason in the hide situation for the concentration of tanneries.

Until the Civil War, as a consequence of the factors regarding bark and hides, our tanneries were dispersed over all the states. The tanning industry, in 1860, was fifth in rank in the numbers of establishments. But the plants in New England and

the hardwood forest area had three times the capacity of those in the South and West.

Range Cattle and Packers.—After the Civil War the trans-Mississippi railroads opened the western ranges to the cattle and sheep industry. This was followed by the growth of the Swift, Armour, and Morris packing houses at Chicago. Their success in providing a practicable refrigerator car for dressed meat centralized the slaughter of cattle and sheep for the first time. In turn, the localization of slaughter, heaped in one spot a great quantity of hides and skins, a new situation for the tanning industry.

The immediate effect of this new circumstance was to plant a string of tanneries around Chicago, in Michigan and Wisconsin. The forest was still the lodestone for tanneries but the packing houses were beginning to exert another pull. The Michigan and Wisconsin forests furnished the bark to tan Chicago hides at such places as New Holland, Sheboygan and Milwaukee. The packers themselves soon became tanners, this being one of the steps in their development of by-products. The packers' tanneries were in Michigan, Wisconsin and Illinois.

Under the stimulus of great quantities of hides the tanneries near the packing houses attained to greater size than heretofore was common. The larger tanneries sought better methods. At first, the managers turned attention to mechanical improvements but at last they called in chemists. Although tanning is essentially a chemical problem, tanners had been satisfied with "rule of thumb" operation until about 1890, when the chemists were attached to the tannery staff. The move was not revolutionary, for the chemists on their part had hitherto ignored the application of their knowledge to tanning problems. But slowly the chemists mastered the chemical reasons behind the ancient "rules of thumb," and discovered many of the rules to be wrong or untrustworthy. Under the guidance of the chemists tanning procedure was conducted with greater accuracy and less guesswork.

† **Tannin Extract.**—One of the contributions made by the chemists was the manufacture of tannin extracts to replace the

use of bark. The tannin content of bark was removed by soaking and then the tannin concentrated. This saved the loss of bark and tannin on the relatively short journey from forest to tannery, and, moreover, eliminated all the labor and most of the space for storage of bark at the tannery.

In the tanning processes the use of extract in place of bark gave more exact results, for the extract could be standardized. The known tanning content of extracts saved time in producing leather and the ease of handling the extract conserved labor. Moreover, different extracts could be blended to get any desired result.

While all the foregoing advantages in the use of extract were important, its use was vital in breaking the clutch of the forest on the tannery. To be sure, the extracts had to be made in or near the forest but the tannery itself was free to locate anywhere; it could be put at the source of hides or at the market for the finished leather. To place the tannery close to the packing house was advantageous, for although hides do not deteriorate rapidly they, nevertheless, lose value on prolonged journeys. When fresh hides could be dumped into a near-by tanner's soaking vat it was not necessary to put those hides through the drying, salting or pickling processes required for lengthy transportation. The tannery in turn, was saved much of the reverse process.

Finally, the disappearance of local tan-bark forests does not mean any longer the closing of the local tanneries, for extract may be shipped unlimited distances. The great reduction in our national resource in tan-bark has caused us to turn to the excellent quebracho tree of Argentina. In former times the tannery would have moved to South America; today, instead, quebracho extract is shipped in tank cars and boats from the places where the tree grows to the American tanneries where the extract is used.

Fine Upper Leathers.—American tanners before 1880 were unable to supply the domestic demand for high-grade light-weight leathers used in the uppers of shoes, particularly those for women. Our craftsmen limited themselves to the output of a leather made from imported goat skins tanned with hemlock, oak or chestnut.

While this leather was accepted for the cheaper grades of shoes it was refused by the manufacturers of fine shoes.

For the best shoes "French kid" and "Morocco" were imported. The former was a soft, pliable leather made from the skins of young goats by the tawing process used for glove leather. We imported this leather to the amount of ten million dollars a year. "Morocco" was a goat leather, manufactured in Turkey by a sumac liquor. It ranked below "French kid" in the estimation of the shoe manufacturers and shoe buyers.

American tanners in Philadelphia shortly after 1875 began to market an imitation "morocco" from imported goat skins, the leather being tawed with a mixture of alum, eggs, salt, olive oil and water. The resultant white leather was dyed (generally black) and the wearing surface highly polished with glass rollers. It was given flexibility by filling the flesh side with oil and wax. This "American morocco" was so instantaneously successful that by 1880 the imported variety constituted hardly 10% of the domestic consumption of morocco leathers. The tanneries in or near Philadelphia, Wilmington and Newark used so much goat skin that New York, by 1890, was the largest goat skin market in the world. The skins came from American buyers posted in interior Asia, Arabia, northern Africa, Central and South America. The tanners who produced morocco were the forerunners of the makers of chrome leather.

For a quarter of a century after 1880 "kangaroo" leather was extraordinarily popular for shoe uppers. The Australian government, before the use of kangaroo skins for leather, had placed a bounty per head on all animals destroyed, but the excessive hunting caused by the demand for kangaroo leather led Australia to reverse its policy and to enact a six-months' closed hunting season on kangaroos. Yet the animals were so nearly exterminated that breeding farms (like present-day fox farms) were profitable. The kangaroo skin was both tawed and tanned, in the latter case with the Australian mimosa tree. Kangaroo leather is still produced but is little known to the younger generations. Its day has passed not because it lost favor but for the reason that kangaroos have joined the "Dodo" bird.

Seth Boyden of Newark, New Jersey, was one of the in-

ventive geniuses whom we like to regard as typically American. Among a long list of extremely different things his brain conceived, one was "patent" leather, the process of manufacturing which he sold to tanners in New Jersey and Pennsylvania. "Patent" leather was a light-weight product whose surface was carefully finished with linseed oil and varnish. For over a century, Newark and points along the Delaware River have possessed large tanneries where this special leather has been produced.

× **Mineral Tanning.**—The tanners of "American morocco" in and near Philadelphia were among those who operated upon a large-scale. They were among the first to realize the contributions a chemist could make to the age-old art of tanning. The chemists suggested about 1890 that "morocco" could be produced by various metallic salts, notably those of chromium, iron and aluminum. But when the practical tanner followed the hints of the chemists they found that although the metallic salts produced leather it was too hard and brittle to have any utilitarian value.

Only one practical tanner continued to experiment with leather made with metallic salts. That man was Robert H. Foerderer of Philadelphia. In 1888, he conquered the difficulties that beset him and marketed a chrome leather to which he gave exultingly the copyrighted name of "Vici" kid. After Foerderer pointed the way, mineral "tanning" immediately became popular. North and south of Philadelphia, along the Delaware and across that river in New Jersey, the "American morocco" tanneries shifted to the new chemical leather. Near the shoe factories in Massachusetts old tanneries were reopened and new ones built to make the new leather close to its chief buyers. Chrome leather swept out of our market the competing light-weight leathers of other nations and we even exported our product to France, the home of "kid." Chrome tanning may be conducted wherever imported goat skins or light-weight calf skins may be obtained.

Of recent years effort has been made to produce heavy sole leather by the chrome method. These experiments have been sufficiently promising to be significant for the future.

Growing Scarcity of Hides.—The change from vegetable to mineral tanning was not so revolutionary as the situation that has confronted the tanners since the opening of the new century, namely an increasing scarcity of raw materials and a growing pressure from the competition of substitute products. For three hundred years American tanners enjoyed unusual privileges and opportunities because our country has been so wealthy in the resources essential to the tanning industry. Our forests furnished abundant supplies of tan-bark, while after the Civil War our vast area of free grazing land promoted an extensive cattle business. But the day of plentiful raw material is over. The forests have been depleted to such an extent that we have had to learn rigid economy in tan-bark, forcing us to make a close study of the chemistry of tanning, in order that every bit of effective tannin might be utilized. We have had to go further and either import new tannin-bearing material such as quebracho from Argentina or place great reliance upon mineral tanning. The threatened shortage of tan-bark, however, is by no means so serious as the threatened scarcity of hides.

Decline of Ranching.—Of the beef animals of the world 55% are in the Americas, North, Central and South, so that any changes in the animal industries of these three countries upsets the leather business of the world. Our western plains and the similar area of Argentina contain more cattle per capita and per square mile than any other places in the world. Unfortunately for the continuance of cheap leather, ranching is a declining occupation in each of these two regions. The free grass areas were first contested by the detested sheep herders and then by the bona-fide farmers. Much of the former range was put into farm and what was left had to be fenced into corrals, a much more expensive method of producing cattle products than free grazing on public lands.

While the numerical decrease in cattle may not be serious from the viewpoint of the meat industries (see Chapter XII), certainly there are no offsets to tanners, for fewer cattle mean fewer hides. Furthermore, many farmers have turned from beef animals to dairy herds, and the ranchers have been forced

to improve their breed of beef stock. Both these changes have tended to increase the price of leather by decreasing the number of first-class heavy hides. In any given number of dairy cattle more bull calves and worn-out cows are slaughtered than in an equal number of range animals. Because their hides are thinner and more "spready," it happens that neither calves nor cows yield as valuable hides as steers.

Quality of Hide Lowered.—From a different cause but with the same effect, the changed attitude of cattlemen toward breeding reduces the stock of sole leather. Since wild cattle have the thickest hides and the highest bred beeves the thinnest, it follows that whenever ranchmen turn attention to improving breeds they aim a blow at the best grades of leather. England with its blooded stock long ago gave up using domestic hides for sole-leather and went instead to the unimproved herds of Portugal or Spain for supplies. We formerly depended on the wild Texan cattle for our sole-leather hides; but Texas, like all the rest of the cattle country, has become more interested in high-grade beef than in top-notch leather. Our resort to Argentine hides will not suffice us for very long because the incentive there also is toward meat production, not hides.

On both the farms and the range, the modern methods of feeding, especially in the winter, tend to lower the quality of the hide for leather purposes. Wherever oil cake of any kind is fed to cattle, their hides become greasy and weak fibered. The practice of cake feeding is so extensive and the result so universally bad for the tanner that the price of hides taken from cattle that have been fattened in this way is reduced.

Finally, hides have become a mere by-product of the meat business. Before the great packers appeared the hide market bore quite direct relations to the leather demands, but with centralized slaughter the control factor is the consuming demand for meat. Tanners, therefore, face recurrent feasts and famines in the hide supply. Their position between hide producers and leather users is a weak one at best, but with the hide market entirely out of hand tanning has become excessively speculative. The months required for tanning have often thrown the costs

of leather entirely out of harmony with the prices of hides prevailing when the leather was sold. A tanner successful year after year is either an excellent prophet or a favorite of Lady Luck. There are hundreds of tanners who have enjoyed neither distinction.

Scrap Leather.—So acute has been the scarcity of sole-leather material that every scrap of it is used and many pieces over and over again. In fact, the collection and distribution of scrap leather has become one of the most thoroughly organized branches of the leather industry and the scrap dealer is a useful and economic member of society in general, as well as a valuable adjunct to his own trade. Splitting machines that will divide a hide accurately into two to five pieces have been perfected so as to make every hide go as far as possible. In order to keep our waning supplies of heavy hides in our own country, our big packers insist when live animals are sold abroad that the hides be returned to the United States. Congress, in 1907, recognized the shortage of hides in America and repealed the duty on imported supplies. The tariffs since that date have kept hides on the free list.

Increasing Use.—The scarcity of heavy hides would not be so serious if the demand for sole-leather were not every day becoming greater. Leather house furnishing, from grandfathers' chairs to library wall coverings or picture frames have been very popular; leather trunks, bags and suitcases were never more desired; cases for guns, fiddles, golf clubs and safety razors are all made of leather, to say nothing of automobile seat-coverings and tops which take two and a half hides per car. No one needs to be convinced that sole-leather is in great demand for innumerable things beside shoes.

Substitutes.—Smaller supplies with which to meet an increased need can have but one result; substitutes must be found. One variety of substitute has been on the market for some time. This is a fabric impregnated with leather-like substances and sold to replace leather for upholstery, art objects and toilet articles. It has the advantage of being manufactured in standard

lengths, widths and qualities, but has the disadvantage of a peculiar odor. A different substitute has been tried out in the engineering field; instead of leather power-transmission belts we have turned to rope, wire, web devices and individual motors. But until recently there was no substitute for leather for shoe soles.

Manufacturers have been experimenting for several years to find something that would take the place of leather for footwear. Woven rope alone, and woven rope impregnated with a waterproofing substance, fibrous materials compacted like cardboard, mixtures of scrap leather and rubber, all these have been tried but without much success. By shutting out imported raw hides and by greatly increasing the demand for leather, the Great War stimulated the spirit of invention. Rubber manufacturers were the first to seize the opportunity and flooded the market with fiber compounds to replace sole-leather. The high price of leather kept these substitutes relatively costly, but with increasing competition and improved methods of manufacture the price fell. Indeed, leather substitutes flooded the market so freely that tanners became apprehensive, and started advertising the virtues of Real Leather.

A complication has arisen because, despite increased scarcity of materials, the tanning industry is much over-developed. About a quarter of all the tanneries produce less than \$100,000 worth of leather per year. The relative simplicity of the business has encouraged small-scale operation, with the result that we have more tanneries than consumption demands. This not only demoralizes the industry but wastes the scanty material.

The automobile has reduced the demand for harness leather, which formerly was a large item in tannery output. The riders in automobiles also wear out less shoe leather and thus lessen the demand on tanneries. From time to time, leather upholstery for automobiles has been popular but the makers of leather substitutes have been most active in capturing this market.

The almost universal use of rubber heels (75% of men's shoes are factory-equipped with them) has had a marked influence in reducing the demand for sole leather, while the popularity of low-cut shoes has diminished the need for upper leather.

The use of canvas-topped rubber-soled shoes for children and for sport use, and the use of satin and other fabrics in women's shoes has reduced the call for upper leather. The favor shown strap and gore types of women's sandals has been a hard blow to leather makers for these styles use the least leather of any shoes.

The large amounts of army leather supplies accumulated during the World War, comprising saddles, harness, leather coats, leggings and shoes were a weight on the market for five years after the Armistice.

After 1920, therefore, the leather industry presented the curious spectacle of one whose fundamental bases were contracting and foreshadowing future dearth, and also one whose long run demand was increasing, but one whose immediate problem was surplus capacity, oversupply of stocks and formidable losses in demand. In the depression which extended from 1920 to 1927 many tanneries were liquidated or foreclosed, while the industry as a whole operated at half to two-thirds capacity.

Upper Leather.—In like manner, but to nowhere near the same degree, leather for uppers is becoming scarcer and higher-priced. Goatskins, used primarily as the raw material, were curtailed by the World War and it will take years for the supply to catch up with the demand, if it ever does. Furthermore, as the exhaustion of sole-leather puts a greater pressure on upper stock, it is only a question of time when a substitute for upper leather must be found. Felt might be used as a shoe upper material except for its poor wearing qualities. A woven fabric of some sort probably will be the solution of the difficulty. A very fertile field for investigation along this line is an artificial leather made with a minutely woven fabric base impregnated with gelatinous or albuminous matter. Since most fabrics except silk or wool are derived from plants, there need be no fear of shortage of supply. At any rate, it seems probable that the not distant future will witness some kind of light, artificial leather other than those we now have.

The day of artificial leather does not necessarily spell doom to tanners because leather has a great many uses not touched by

the substitutes and, in addition, many people like leather for itself; they would not accept anything else unless the price of leather were prohibitive. The presence of substitutes relieves part of the burden on the leather industry and, by so doing, enables the price of leather to be kept within reason. Consequently, artificial leather may be more of a benefit than a harm to the established tanning industry, while to the public, artificial leather will be unquestionably a boon.

Large-Scale Production.—The bane of the tannery industry has been the large number of small plants erected in response to scattered materials. The appearance of packer hides and extract tanning, however, began a change toward larger-scale operation. Many of the chrome leather plants also were large affairs. The tendency of late years has been toward large-scale production, so that more than a fourth of all tanneries have products of more than one million dollars a year. Many of the smallest tanneries, meanwhile, have sunk quietly into oblivion. For thirty years the number of tanneries has been decreasing, while the normal scale of operation has expanded. In two main branches of leather manufacture—sole and upper leathers—combination of small units into giant corporations has occurred. In the sole leather business the United States Leather Company is the leader, a position held by the American Hide and Leather Company among the makers of lighter leather.

* **United States Leather Company.**—The United States Leather Company is a thoroughly integrated organization, owning and operating timber lands, sawmills, extract works, tanneries, glue factories, machine shops, woodworking shops, laboratories and warehouses. From 1905 to 1927 the company's name, due to a reorganization, was the Central Leather Company, but in 1927 another reorganization placed the original name on the company's letterheads. In connection with its forest properties the company owns and operates 150 miles of railway and a longer mileage of tramway. The company's 86 tanneries are located in ten states: New York, North Carolina, Georgia, Virginia, West Virginia, Tennessee, Kentucky, Maryland, Wis-

consin and Pennsylvania, but 37 are in Pennsylvania. The nine sawmills are all in Pennsylvania. Of the eight extract works, four are in Tennessee, two in Virginia, and one each in North Carolina and Pennsylvania. The two glue works are at Milwaukee, Wisconsin and Williamsport, Pennsylvania. Although heavy leather is the principal product, all grades are sold and, as well, the company markets lumber, glue, grease and tankage. Of the American output of heavy leather this corporation controls about one-third. Large earnings were made during the World War and, despite distress for all tanneries since 1920, the company maintained a strong financial position.

† **American Hide and Leather Company.**—In the field of light leathers the American Hide and Leather Company (incorporated in 1899) manufactures 75% of all the upper leather produced in the United States. Of its 20 tanneries, 13 are in Boston, three in Chicago, and one each in New York City, Milwaukee, Sheboygan, and Ellenville, New York. Until 1922 it also possessed a tannery at Binghamton. A Peabody, Massachusetts, tannery which it purchased in 1923 it resold three years later. It also owns the Pennsylvania Hide and Leather Company, which operates three tanneries. The parent company has never paid a dividend on its common stock and from 1921 to 1927 it had paid nothing on its preferred stock. Before 1921 its preferred dividends had been irregular.

† **Present Distribution of Tanneries.**—Of the 600 tanneries in the United States in 1927 Massachusetts had a fifth. Next to this state in number of tanneries stood Pennsylvania, New York and New Jersey. This group represents the old order as well as the new. Another group followed which was almost entirely of the new day. This comprised Illinois, Wisconsin, Ohio, Michigan and California, each having 20 to 30 tanneries.

In size, the California tanneries were smallest and those of Wisconsin largest, the latter averaging four times the size of the former. The Illinois, Michigan, and Ohio tanneries were also of considerable size, while those east of the Appalachians were generally smaller, except in Pennsylvania where some large

plants were found. Delaware, which has only 16 enterprises, nevertheless ranks above Massachusetts in the average size. New Hampshire, Maryland, North Carolina, Tennessee and West Virginia, although not claiming many tanneries, nevertheless have relatively large ones. In short, tanning is still spread over 32 states, no one of which may boast that its plants average more than 200 employees. Tanning, despite the tendency toward large-scale operation, is still a scattered, relatively small-scale business in which speculative risk is a large factor.

The output of tanneries is without exception the raw material for further manufacturing. Of all the manufactures of leather, shoes are by far the most important.

CHAPTER XIX

THE SHOE INDUSTRY

The Cobbler's Standing.—Human interest has permeated the manufacture of shoes from the arrival of Thomas Beard and Isaac Rickerman in Salem, Massachusetts, in 1629, down to the latest recruit in a modern factory. Shoemakers both in America and Europe held an exalted place in the esteem of their fellow-men, and the trade was called "The Gentle Craft." Inasmuch as shoe-making was sedentary, noiseless and repetitive, it furnished plenty of opportunity for the craftsmen to mull over politics, religion or philosophy. The shoemaker's shop was looked upon as a clearing house of opinion and it is but natural that many a bench-warmer has risen to seats more eminent. St. Crispin, the patron, whose birthday, October 25, was celebrated for centuries by the craft; George Fox, the founder of the Society of Friends; Roger Sherman of Connecticut and Francis Lewis of New York, signers of the Declaration of Independence; Mad Anthony Wayne, almost legendary revolutionist; Nathan Tufts, founder of Tufts College; Henry Wilson, eighteenth Vice-President of the United States—all these were at one time in their lives humble wielders of the awl and waxed thread. Only the printer's trade has given more men to fame than the shoemaker's. It is said that Henry Wilson, when Vice-President, returned often to the shoe shop of Natick to discuss national problems with his erstwhile fellow craftsmen; and that the pith of these forums was afterward presented by him to the Senate.

Most of the old shoe shops contained a Bible, a dictionary, and a weekly newspaper. Sometimes one worker was appointed "reader" to the others who did his work for him as well as their own. The shoe shop, blacksmith shop, miller's office, and town meeting were the germinal beds of democratic self-government.

First American Shoemakers.—As soon as British colonies in America were deemed reasonably permanent, both the financial backers in Britain and the colonial governments began to offer special inducements to British artisans to emigrate. Among the earliest craftsmen to be swayed by the offers were tanners, curriers and shoemakers. Thomas Beard and Isaac Rickerman, Londoners, sailed for Salem in 1629 taking with them shoemakers' tools and a supply of leather. Rickerman did not stay in America but Beard was granted 50 acres of land and ten pounds sterling per year to defray his living expenses. He lived and worked at his trade in Salem for fourteen years, when he moved to Portsmouth. Philip Kertland arrived in Lynn in 1635 and three years later was granted ten acres of land in recognition of the service he rendered. Henry Elwell, another shoemaker, settled in Scituate in 1634. A similar story could be told of the colonies south of New England; shoemakers from the start were offered special inducements to settle and ply their art. In Boston in 1651, the General Court granted a three-year charter to certain shoemakers to establish a guild after the European pattern. But a new colony was not a favorable place for a guild, so this experiment was abortive. Because of the extra favor given to shoemakers it was not long before every colony had these artisans. With the increase in villages and towns, shoemakers spread over the land so that in the heyday of the colonies these craftsmen were everywhere.]

Local Industry.—The shoemaker's handiwork was limited to his own locality because he had to depend on the neighboring farmers for his supply of raw material, a most uncertain source. There was no definite place from which he could secure leather in large quantities at all times. He was equally restricted as to a market for finished wares, since there was no way to ship large numbers of shoes except by horseback or wagon, methods which were prohibitive by reason of their cost.

[Shoe-making then depended upon raw materials, labor and market all in the same neighborhood. In the back country it was a household industry, one of the men of the family making the shoes for all the members.]

Errant Shoemakers.—Some shoemakers, especially those near the frontier, fared forth regularly from their town shops to travel through all the outlying country districts in order to make up shoes for settlers' families right at their own homesteads. The farmers cured and tanned the hides required for raw materials and then waited for the wandering artisans to come to their doors. The errant shoemakers were welcome visitors long awaited at frontier clearings. The tools requisite for shoe-making were extremely simple and easily portable: a lap-stone, a hammer, variously shaped awls, and a shoulder stick were the only ones necessary, while an apron and some waxed thread completed the equipment. This simple outfit had not changed since the time the Egyptian pyramids were built, a fact proved by inscriptions. Skill was the one great asset of a shoemaker and although it required ten to twelve years' apprenticeship, once acquired, it could be applied as well in one spot as in another.

The practice of travelling continued among shoemakers from early colonial times to the opening of the Civil War. For this extension of a custom long after it was economically necessary one important reason was that shoemakers were particularly subject to tuberculosis. Their small stuffy shops and crouched working position were inimical to health. Hence they varied their jobs. Some went to sea but others tramped across the land, earning their way by their trade. Henry Wilson, "the Natick Cobbler," was one who did this. Another reason for "whipping the cat"—journeying—was to gain experience in the craft.

The City of Lynn.—In common with all other villages, Lynn, Massachusetts, had its own shoemakers, beginning with Philip Kertland in 1635; but whereas other towns had only a few craftsmen, Lynn eventually became the seat of a shoe industry of considerable size. A combination of circumstances gave Lynn advantages that no other town enjoyed and enabled her to forge to the forefront in the manufacture of shoes.

The natural outlet for the energies of Lynn's people was the sea, for the town is half-way between Salem and Boston, the two principal ports of colonial New England. It was accident that turned Lynn citizens from becoming sailors and instead made

them shoemakers. By chance, a Welsh immigrant named John Adams Dagys, a shoemaker of great genius, settled in Lynn. Dagys—his name is sometimes written Daggs, Dagyn, or Dagyr—~~was by no means the first man of his trade to arrive in Lynn,~~ but he differed from his predecessors in that he was a man with a great idea. His idea, ~~now commonplace but at his time an~~ innovation, was the application of the principle of subdivision of labor to the art of shoe-making. Discarding the age-long method of production by which one man made one shoe completely from start to finish, he substituted the system by which each worker specialized upon part of a shoe and did that work exclusive of all else.)

(In addition to revolutionizing the organization of the processes of manufacture, Dagys also made the product more suitable for its market. Shoes well adapted to the settled conditions of Europe were ill adjusted to the pioneer state of the new world, so Dagys imported samples of the English and French art, dissected them, found where they were faulty, and then cut out and sewed together new shoes without the flaws of the foreign-made articles. Since the American shoes so devised were simpler and stronger than the European, they were better accommodated to a system of subdivision of labor, for almost anyone could learn to sew together the few individual parts of which they were composed.

Work at Home—Once the idea of subdividing labor upon a shoe was accepted, the situation of Lynn lent itself to the rapid adoption of the system. In the making of a shoe a much larger number of workers are required for sewing individual pieces of the leather to linings, and then binding the pieces into one complete unit to form the upper part of the shoe, than are needed for cutting out and preparing soles or joining uppers and soles together. Furthermore, since the work upon the uppers was light and easy to perform, it was well adapted to female labor. Fortunately, in the vicinity of Lynn there were a large number of women eager to add to the family income by moderate tasks of this nature. In the famous fishing towns of Gloucester, Beverly, Sailem, Marblehead and Boston, the wives, daughters and sisters of men absent on long cruises were delighted with

work that gave them an immediate, substantial return. Hence, after the introduction of the Dagys system of manufacture, there was hardly a fisher's cottage along the shore north of Boston that did not have some female member connected with the shops of Lynn, working, however, in her own home.) Lucy Larcom, the New England poet, has made this feature of the shoe industry memorable through her poem "Hannah Binding Shoes."

The men, too, engaged in shoe manufacture between fishing voyages and oftentimes they took cases of cut parts aboard their vessels, worked upon them in idle moments, and delivered the finished product when the boat was warped to the home wharf.

Farm families inland in New Hampshire and Maine also took up shoe-making. Storekeepers sometimes, when trade was slack, made a few pairs of shoes for the "manufacturer." The parts were cut upon the premises of the "manufacturer" because cutting so as to get the most out of a side of leather was (and is today) a delicate art. Centralized cutting, besides economizing raw material, saved the transportation of materials, except those that actually were part of the finished shoe. Men took up the business of carrying shoe parts to scattered remote workers, and bringing back finished shoes to the "manufacturer." The carriers received a percentage of the worker's pay. The latter were often paid in goods, or in orders on particular stores. These orders—discounted—sometimes circulated as money.

⌋ Dagys, by splitting the art of shoe-making into small parts, each one easily learned, filled a long-felt want and started the north shore of Massachusetts upon a career of shoe manufacture on a scale nowhere else attempted. By 1795 there were 200 master workmen and 600 journeymen in Lynn alone, and the output of shoes per year reached 300,000 pairs. ⌋

Supply of Raw Material—Lynn was able to secure all the leather she needed from the vessels which made nearby Salem their home port or which carried hides into Boston, Lynn's next-door neighbor. ⌋ That the harbors of Massachusetts Bay should gain early supremacy in commerce was due partly to a fact that is often overlooked, namely, that the roadsteads were open nearly all the year, whereas the Hudson and Delaware Rivers were closed

yearly for months by ice. In the leather business this condition deflected large shipments of hides, that otherwise would have entered at New York, to the harbors about Boston. To her position near these open ports Lynn must largely attribute the growth of her shoe business. Hides from California, Central and South America, the southern colonies and states, and New Orleans; rosin gum (for waxing the threads) from the Carolinas; thread from Florence; and goatskins from Europe and Asia, all were heaped in profusion on the wharves at Salem or Boston. The hides and skins were converted into leather at Peabody and other towns adjacent to Lynn.

Markets.—Massachusetts shoemakers had a surplus of shoes to sell elsewhere as early as 1761. The shoes were added to the miscellaneous cargoes of coasting vessels and a regular trade was developed with the southern colonies and with the outposts at Nova Scotia and the Maritime Provinces. In 1768 as many as 13,000 pairs of American shoes were entered at American ports. The normal price for men's ordinary shoes between 1700 and the Revolution was one dollar a pair. During that war the price doubled and for the better grades of shoes never dropped back to pre-war quotations.

The first full cargo of shoes sent out of Boston was carried in the sloop "Delight" which sailed for New York in May, 1818. The same vessels which carried hides to Massachusetts took back on their return voyage the shoes made from those hides, shipped in flour barrels like crackers, packed 75 to 100 pairs per barrel. It was not until 1840 that shoes were packed in special wooden cases and not until 1850 that each pair was put in a separate box. In "Two Years Before the Mast" Dana described how eagerly the Mexicans, who then (1840) owned California, paid \$11 for shoes that sold for \$3 at Lynn, and made from leather that came from San Diego and which, consequently, travelled twice around Cape Horn. Lynn shoes were also worn on the plantations in the West Indies and in our own southern states, so a market was not lacking to the little shops in the thriving Yankee towns. Danvers—north of Lynn—specialized in heavy, cheap shoes called "brogans," which sold for a dollar a pair (or less) until

the Civil War, and for \$1.25 as late as 1900. These found their best market upon southern slave plantations. Since labor, raw material and market were all brought together at Lynn, it is natural that the city should attain the leadership in shoe manufacture.

Other Shoe Centers.—The fame of the Boston district for shoes, however, did not rest entirely with the towns along the north shore, for from the time of the Revolution the south shore, too, has had a full share of the prestige. This section had all the advantage in the procurement of raw materials or the disposal of the product that Lynn could claim; it needed only a start to set the industry in motion. That impulse came at the close of the War of Independence when returned Yankee soldiers, who had been taught shoe-making by the British, took up farming in the neighborhood of Randolph and as an odd-time job added shoe-making to their agricultural occupations. The shoes thus manufactured were exchanged at the nearest store for household supplies. Many of the storekeepers gradually drifted into functioning as wholesalers or commission merchants, and later became manufacturers controlling from a centralized point a scattered labor force on the farms of the neighborhood. The storekeeper-merchant-manufacturer bought the raw materials, cut them into parts, distributed these to the farms, collected finished shoes, and disposed of them through Boston or Providence.

At first no south shore town monopolized the business; it was important in a dozen. Shortly before the Civil War, however, two or three families moved into Brockton and by their unusual zeal and business acumen, raised their town above all its neighbors in the making of shoes. The great demand for army shoes during the Civil War placed Brockton firmly upon the pinnacle of leadership among the south shore towns, and in fact enabled Brockton to contest first place with Lynn.

Geographic Specialization.—There has been one important and interesting distinction between Brockton and Lynn; namely, Lynn and the north shore in general always have specialized upon women's shoes, whereas Brockton just as persistently has manu-

factured men's shoes. Along the north shore, inasmuch as the communities were interested principally in fishing, there were many women but few men available for shoe-making; as a result, the favorite type of work was that of a light variety which women most easily could perform. Since the preponderance of women was a permanent feature of this district, the manufacture of women's shoes became stabilized. The influence of an early start had its bearing also, for Dagys was particularly skilled in manufacturing women's shoes. The south shore, on the contrary, due to the fact that it had few good harbors, never equaled the north shore fishing fleets but instead turned attention predominantly to farming. The men were home all the time and could do the heavier work required on men's shoes. Moreover the originators of the trade in this area having been trained as shoemakers while in the army, were most adept in the making of men's shoes. Since the chief bread-winners of the families were never away from home for protracted periods there was no need and no time for the women of the household to seek accessory income from bye-time jobs. So there has been a marked division in handicraft between the towns north of "The Hub" and those south of it.

Boston's Banking Supremacy. Both Brockton and Lynn benefited by their close relation to Boston in that Boston was the chief financial center of the country at the time the shoe industry was developed. Boston financial institutions had business relations throughout the South and West and notes, mortgages and other commercial paper from these regions passed through the Boston banks. Since the principal markets for Massachusetts shoes were in the South and West, and since all shoes were sold on six, ten, or twelve months' credit, it is apparent what an advantage it was to Lynn and Brockton to be so conveniently located in proximity to the Boston credit experts and money marts.

Boston not only did banking for the South and West but was also a great wholesale center. Groceries, dry goods and hardware all passed over the Boston wharves en route to Philadelphia, Savannah, Charleston, Cuba, the West Indies, South America, the California coast, and Australasia. The same articles

from the same source travelled over the river highways to the inland western frontier. Nothing was easier than to include shoes also in the shipments of goods that were going forward from New England. A big factor in this wholesale trade was the large number of New England emigrants who settled the new sections and who naturally maintained trade relations with their old homes. The establishment of business houses, both wholesale and retail, in the pioneer districts was closely bound up with Boston's banking supremacy. The Yankee shoe trade followed the Yankee emigrants and these were influential in maintaining or extending the fame of Yankee shoe shops. In 1828 the total sales of shoes by Boston jobbers amounted to \$1,000,000 per year; by 1856, this first million had been multiplied fifty-fold for one year's transactions. Beginning in 1829, Boston wholesalers gave up consigning shoes to merchants, a method used to introduce them in new markets, and insisted that buyers come to Boston. Of course this added to New England's prestige. At the opening of the Civil War no other single American industry, not even the cotton mills, employed as many hands as the shoe shops.

Shoe Manufacture Outside New England.—Although New England was ahead of other sections in the commercial development of shoe manufacture, there were many shoemakers elsewhere. In New York City and Brooklyn the business attained considerable proportions, particularly in the high-quality grades. Of course, this was due to the metropolitan character of New York after 1825. The cities in northern New Jersey after 1761 made shoes in sufficient quantities to have a surplus to sell in competition with New England. This was in part a reflection of the market in New York City and in part due to the supplies of leather from New Jersey tanneries. Philadelphia, likewise, has possessed shoe manufacturers from colonial days. Because of the size of the city, its political, social and commercial importance, the shoemakers of Philadelphia from the beginning of manufacture have catered to the classes rather than the masses.

Aside from these centers, where shoe-making was upon a com-

mercial scale, the business was conducted in nearly every community in the country upon a small-scale to meet local needs.

New England's distinction rested upon the mass output of medium grade and cheap shoes. She shod the masses and slaves.

Standardization.—By making so many pairs of boots and shoes, the Bay State artisans learned secrets unknown to craftsmen with a smaller output. For example, most boots, produced by the latter, although made to order, were poor in fit. In fact, they were so tight that the toes and heels of the wearer's stockings sometimes had to be soaped in order to get the boots on at all and corns actually were believed to be hereditary. The New England shops instituted the practice of making "rights" and "lefts," first for men's footwear, then for women's, and finally for all types. The next improvement was to use tin patterns around which the parts were cut from leather, thus giving greater precision and incidentally saving much leather. Out of this improvement came the standardization of sizes and uniformity in fulness at the instep. For example, men's shoes were made to vary one-twelfth of an inch in width and one-third of an inch in length, for each size. Size 5, measuring 10 inches in length, was taken as the standard from which to gauge all other sizes. Since the Yankee shops specialized on cheap shoes, selling around \$1 a pair, a price that suited the needs of the largest number of domestic consumers, they had the mass output that induced standardization and then profited most from it.

Small-Scale Industry.—The outstanding feature of the shoe industry, then, was its remarkable concentration near Boston, although it was represented in every section of the country by small local shops or by wandering artisans. A second prominent characteristic was the long continuance of skilled hand labor which had as corollaries small-scale operation and labor dominance.

Notwithstanding that machines were beginning to enter the cotton industry in 1750, when Dagys, the shoemaker, settled in Lynn, it was not until a full hundred years later that mechanisms began to appear prominently in shoe shops. Shoe-making is

essentially a series of sewing operations. Since no machine for sewing with any material at all appeared until Elias Howe's invention in 1846, and since even then it took years to find a machine needle that would sew through leather, shoe manufacture remained until 1860, strictly a hand labor business. Because it was unaffected by machinery for so long a period, shoe-making became fixed as a small-scale industry. The mass output of New England was obtained from hundreds of small shops.

The "manufacturers"—really factors—who bought leather, cut the shoe parts and distributed them among scattered workers were seldom wealthy men; there were scores of them in Lynn and along the south shore who employed only two or three artisans and were themselves cobblers and did all their work in tiny buildings 10 feet by 14 erected in their own back yards. Since there was no machinery involved and the shops were nothing but small sheds, the only capital necessary was the little required to purchase material, pay wages, and hold the finished shoes until sold. Raw material, however, could be bought, a side of leather at a time, and wages could be furnished one week from the shoes made and sold the week before; consequently, very little money was needed by a man to embark on a career as a shoe manufacturer. Many manufacturers, too, paid in "orders" on some local store and then made an annual or two-yearly settlement with the store. This system, of course, had inherent in it the possibility of exploitation of labor and by the time of the Civil War was generally condemned. Some shops were large enough to house a dozen workers, among whom considerable subdivision of labor was applied. In a few cases independent shoemakers rented bench space in these larger shops.

The First Machinery. The first machinery that entered shoe-making had to do with pegs. As long ago as the 16th century wooden pegs were used to fasten heels to shoes, but it was not until about 1800 that hand-whittled wooden pegs were used to join the upper with the sole. A machine for making the pegs was invented in 1815. Samuel Preston in 1833 perfected an appliance which mechanically performed the pegging operation. It was twenty years, however, before machine pegging was generally

adopted. Pegged shoes, being stiff, were limited to working shoes usually of the brogan type. Pegged shoes still are manufactured.

The next machine was one that rolled sole leather—replacing hammering—to make it hard, compact and durable. The machine did in one minute what it took a man with a hammer an hour and a half to perform. This machine was introduced about 1845. No further mechanical aid was invented until Nichols and Bliss adapted Howe's sewing machine to work on upper leather.

Sewing Machinery.—Elias Howe secured a patent on a sewing machine in 1846. This was one of the great events in American industrial history, for although it would not be accurate to rank the sewing machine as some writers have done with the steam engine, printing and gunpowder in its widespread revolutionary consequences, nevertheless Howe's invention has had an extraordinary influence on the lives and fortunes of countless men and women. Industrial history marks this machine as the beginning of a new era in the manufacture of clothing, apparel, all branches of the leather manufacturing industry, including shoes, and wherever sewing was important. Along with Howe credit is due to Allen B. Wilson and Isaac Singer, who improved the invention.

John Brooks Nichols, a shoemaker out of work, bought a sewing machine in 1851 at a bargain sale. While earning livelihood in sewing pants, Nichols at night experimented with special threads and needles of all shapes to discover a way to make his machine sew leather. At last he succeeded. In partnership with William B. Bliss of Boston, he sought to place his adapted sewing machine in shoe factories for the sewing of uppers.

At first the machines were so heavy that women were temporarily thrown out of the business, but with improvements in the machine they soon flocked back. Not only was it easier to use Howe's invention first for the uppers but it was also more economical because previous to its introduction the sewing of the uppers was the most costly part of the manufacture. One woman by hand could bind only four pairs per day and the cost ranged from 17 to 25 cents per pair, whereas the men using



PLATE 14. An Old-Fashioned Shoemaker. A. E. Cooper (1847-), Hanover, N. H.
(From photograph in possession of author.)

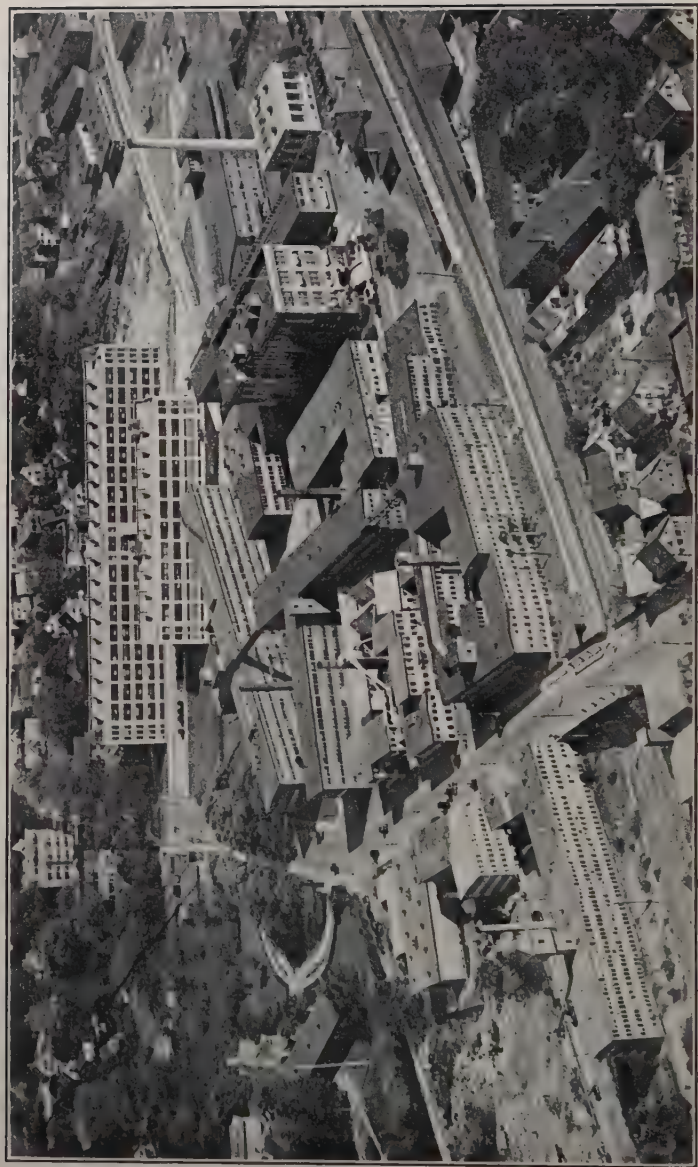


PLATE 15. The "Campello" Plant of the George E. Keith Company, Brockton, Mass. One of the largest shoe factories in New England.

(Courtesy George E. Keith Co.)

the machine could complete 15 pairs of shoes per day at a cost of 22 cents a pair.) The machine did the sewing with greater precision and although the workers received less per pair, the daily wage was increased. (With this beginning other inventions rapidly followed, especially under the stimulus of the Civil War, but the most fundamental were those associated with the names of McKay and Goodyear.

Lyman R. Blake discovered the way to use a machine in sewing soles to uppers. He obtained his patent in 1858 but, lacking capital to push the invention, he sold his rights for \$70,000 to Gordon McKay, a Pittsfield, Massachusetts, capitalist. The latter organized a company which paid its debt to Blake by giving him outright \$8,000 dollars and a first claim on the first \$62,000 profits the company might make. The first firm to use the new device was that of William Porter and Sons, of Lynn, who set up the machine in their shop in 1861. The example was soon followed by all other manufacturers catering to a cheap trade, for the machine produced 300 pairs per day when the utmost a man could make was 15 pairs, and saved 18 cents on each of the 300 pairs it turned out. Between 1861 and 1876 the McKay machines produced 177 million pairs of shoes. The invention more than filled the gap created by shoemakers who enlisted in both armies, and kept pace with the sudden greatly increased demand for men's shoes brought about by the Civil War.)

(With sewing machines perfected for binding uppers and sewing soles to uppers, the bottle neck in shoe production was a process called "lasting," in which the upper was carefully stretched and tacked over a wooden foot form. A laster named Matzeliger invented a "hand method" lasting machine (now obsolete) for doing this work. The inventor died of tuberculosis on the eve of his machine's adoption but McKay formed a company for marketing the invention after Matzeliger's death. The lasting machine was the link between the Singer or Wheeler & Wilson machines used for binding uppers and the McKay sole sewing machine. The lasting machine increased the production of lasting from 60 pairs to 200 pairs and up to 700 pairs per day, the wide range of machine output being in deference to quality.)

The fault of the shoe made by the McKay machines was that the stitching was carried through the inner sole and left a ridge which rasped the foot of the wearer, consequently the invention did not revolutionize the whole industry but only that portion which produced low-priced goods. High-grade shoes were still hand-made by the welt process.

Goodyear's Invention.—A welt is a narrow strip of leather to which the inner sole is first sewed and then afterwards the outer sole is attached. By using this device a sole can be joined to an upper so that no sewing shows on the inside of the shoe, and, a much more important consideration, so that the heads of the stitches do not chafe the foot as was too often the case where the McKay process was used. The welt process, from ancient times, was a difficult method by which to manufacture shoes and necessitated long training on the part of the men who performed the job. The peculiarity of sewing outside the edge of the shoe made it especially difficult to apply any mechanical aid and it was not until 1862 that the secret of using a curved needle to do the work on welts was discovered.

The origin of this ingenious idea by which machinery was practically applied to welt shoe-making is usually accredited to Auguste Destouy, a New York mechanic. His idea was taken up and developed by a man named Daniel Mills and finally brought to perfection by Charles Goodyear, who obtained patents for a welt machine in 1871 and 1875. Goodyear's machine turned out welt shoes which were more comfortable, more exact in workmanship, and cheaper than those formerly made by hand and produced them in 25 times the quantity, so that Goodyear may be credited with laying the foundation of the modern American high-grade shoe manufacturing industry. With a Goodyear machine in the factories, the cost of welting, which by the hand method had ranged from 60 to 75 cents a pair, was reduced at first to 10 cents per pair and later to 4 cents per pair. The number of Goodyear machines advanced from 250 in 1880 to 2,500 by 1895. In that same period the number of machine-made welt shoes increased from 2 million pairs to 25 million pairs.

Displacement of Handwork.—The installation of McKay and Goodyear welt machines formed the basis for a large number of other connecting mechanical devices. Between 1850 and 1900, no less than 4,000 patents were issued to the new industry. These various inventions reduced the labor cost of a hundred pairs of shoes from \$408, which it had been under the handwork system, to about \$35. The last hand process to remain in the factory was the cutting of the parts of leather that formed the upper part of a shoe. It was not until fifty years of experience with shoe machinery and by the expenditure of about a million dollars that a machine was finally invented that could do this work. Another machine that took years of time and hundreds of thousands of dollars to perfect was the "pulling over" machine, one that made obsolete Matzeliger's "hand method" lasting machine. The consequence of all these improvements is that today a shoe may be completely manufactured by means of machines. It does not often happen, however, that any one factory possesses the complete line of machines; usually some processes are relegated to handwork; nevertheless, the possibility remains of making a complete shoe by means of machinery.

The sudden revolution in shoe manufacturing methods is one of the most startling features in regard to the industry. At the time of the Civil War shoe-making was one of the industries which had yielded least toward a factory régime. Today, the shoe industry is just as markedly an example of complete mechanization with the result that in America shoe manufacture alone, of all the important articles of wear, has no foreign competitor. Shoes are better and more cheaply made in the United States than anywhere else in the world. Machines have given to our millions as good a shoe as is worn by our millionaires; the many now have what once the moneyed only could enjoy. To have undergone so thorough a revolution in so short a period is one of the most impressive features in the history of the shoe manufacturing industry.

Machine Leasing System.—Despite the thorough mechanical equipment of a shoe factory, several results that might not be expected have been achieved. Usually the degree to which

machinery is used is the mark of the capitalization and consequent large-scale operation of an industry. Shoe manufacture, although it is one of the most mechanical, has yet retained its characteristic small-scale production. The principal cause for this modern condition was the manner in which machinery was introduced into the business. When McKay took his sewing machine around to the masters of the little 10 by 14 shops employing five or six men, the cost of the machine frightened prospective purchasers. McKay found that he could not sell his device. In order that his efforts might not be a failure, he put his machine into a small shop upon a royalty basis; that is, he retained the ownership of the machine while the user of it, the small-scale employer, paid a tax to McKay for every operation on that machine in the making of shoes. At the start McKay also made gifts of stock in his company to those who installed his machine. These, taken as gestures, turned out to be princely donations. When Goodyear came into the market with his contrivances, he found the leasing system so thoroughly entrenched that he, too, was forced to adopt it.

Merger.—As the manufacture of shoe machinery expanded it was virtually monopolized by three companies specializing in its fabrication; one, the McKay Shoe Machinery Company, engaged in making sewing machines; the second, the Consolidated and McKay Lasting Machine Company, which made the Matzeler "hand method" laster and supplies or equipment for the first group; and the third, the Goodyear Sewing Machine Company. Although these companies were seeking dissimilar markets in that their machines were adapted to unlike grades of shoes, nevertheless the savings that could be effected by combination through the elimination of triple sales forces, repair gangs, and general administrative officers were so great that the three groups came together in 1899 and formed the United Shoe Machinery Company. This company controlled more than 95% of the manufacture of shoe machines. Because in each of the basic companies the leasing system had become thoroughly entrenched, it was maintained by the United Shoe Machinery Company. Despite serious pressure from the largest shoe manu-

facturers to introduce a sliding scale of royalties in accordance with the greater or less use of the machines, the United Shoe Machinery Company has never swerved from standard uniform prices. Consequently, the relative machine cost per pair has been the same for a shoe manufacturer with a production of 300 pairs as for one with an output of 3,000 pairs.

United Shoe Machinery Company.—The United Shoe Machinery Company in 1927 owned 9 factories for the manufacture of shoe and tanning machinery, the principal one being in Beverly, Massachusetts. It maintained branches for parts and service in every important shoe manufacturing center and had foreign branch corporations in Canada, France, Germany, United Kingdom and Belgium.

Besides the manufacture of shoe machinery, the company controlled 55 factories in which were made eyelets, nails, tacks, lasts, brushes, dies, cutters and other incidentals to shoe manufacture. By substantial stock ownership in the Turner Tanning Machinery Company the corporation had a complete line of tannery machinery to sell, and by a 51% ownership of the Hoague-Sprague Corporation of Lynn (which itself controls 10 other factories) the United Shoe Machinery Company had entered the production of cartons and boxes in which shoes were shipped and displayed.

The only effective competition ever offered the United Shoe Machinery Company was by Thomas G. Plant, a shoe manufacturer as well as a machinery maker. But in 1910 the corporation bought all of Plant's holdings.

Twice the corporation has been prosecuted as a trust. The first suit was brought in 1911 under the Sherman Act but the government failed to prove that the corporation was a monopoly in restraint of trade. Again in 1915 suit was brought under the Clayton Act, the principal offense charged being provisions in certain leases that compelled manufacturers to take a line of machinery to get a single machine and exclude rival machines. Moreover, the clauses in some leases provided that the United Shoe Machinery Company "findings"—eyelets, thread, etc.—be used exclusively with their machines. The case was carried to the United States Supreme Court which in 1922 ordered the

company to change its leases so as to remove the objectionable "tying clauses."

Those who bought stock in the company when it was organized have been richly rewarded, for it has paid cash dividends regularly and has given extra cash dividends four times and extra stock dividends six times. In 1915 the company was reorganized and its official title changed so that the former word "Company" was altered to "Corporation." The Corporation in 1927 sold about 300 types of machines and employed a corp of inventors to improve them.

Small-Scale Operation.—The consequence of the policy of the United Shoe Machinery Corporation has been the encouragement of a large number of small-scale shoe manufacturing enterprises. In the principal shoe-making centers such as Lynn, or Haverhill, the local chambers of commerce have erected large loft factories where any desired amount of space may be rented. Inasmuch as the rental includes also power, heat, and light, the only requirements for entrance upon shoe manufacture are either experience in directing the work inside a factory or skill in selling. The most frequent sort of enterprise is a partnership between a man formerly a salesman and another formerly superintendent or foreman, who set up business for themselves. Because no capital need be sunk in machinery, nor in any building, nor in power, heat, or light devices, all of an entrepreneur's capital may be used for operating expenses, and the business may be started upon a very small scale. The result is that in all branches of shoe manufacture, with the possible exception of men's shoes where the tendency although present is not so marked, that the greatest number of factories are operated upon meager financial resources. The number of establishments steadily increases, for in 1914 there were 1,355; by 1919 the number was 1,449; and in 1923 it was 1,606. The value of the product per year is about three times the amount of capital invested, and the value added by manufacture about 50% of the total value of the finished product. The average number of workers per enterprise is 140 which means, of course, that half the plants have many less than this.

Factory Specialization.—One effect of the small-scale operation is a high degree of specialization; most men, upon entrance into the industry, make no attempt to manufacture all of the parts of a shoe. Since the shoe business is highly localized, it is possible for these beginners to manufacture heels alone, counters, toe-caps, "cut-out soles" or findings. Shoe manufacture, then partakes of many of the characteristics of an assembly business, some shops making parts only, others combining various pieces, while a few plants gather all the portions and complete the shoe.

The specialization had begun with the making of heels about 1855. The height of heels had been a mark of fashion long years before. Venetian women walked almost on stilts and it is said that Madame Pompadour started the fashion for high heels because stature was her sole physical deficiency. In America, before 1830, high heels were the vogue, then in 1835 spring heels were adopted. After 1840 no heels were worn until 1855. When high heels were reintroduced, journeymen were brought into the factories to make the heels and this job became a specialty. To insure accuracy and to facilitate the job, it was divided into operations of nailing, shaving, blacking, and polishing. Begun with heels, the specialization spread to many other processes.

Specialization has been noticeable also in the classes of shoes made; no manufacturer makes more than one general type of shoe in any one factory. For example, a factory may specialize on infants', women's or men's shoes but no one factory makes under its own roof all three varieties. Wherever a corporation sells a complete line it either operates particular shops for each class of shoes or manufactures a part of the line in individual factories and buys the rest from other concerns that specialize in their production. Even regions have become specialized; the neighborhood of Lynn has been dominantly engaged in making women's shoes, whereas the vicinity of Brockton has confined its activities to men's shoes. Haverhill became famous for its slippers and soft-sole shoes; Rochester, New York, was best known for its infants' shoes, and Philadelphia for high-priced shoes for women.

Commanding Position of Labor.—Not only has the leasing system retained small-scale operation and resulted in a high degree of specialization, but it has indirectly furthered the power of labor organizations. Since the employers in the shoe industry as a class are not fortified by masses of capital but are really little removed from craftsmen themselves, and since also the fierce competition of universal small-scale operation prevents any high degree of cooperation between employers, and because the industry is so thoroughly localized that most of the workers in it live within one small area, all the conditions for evolving a powerful labor organization have been set up. The localization brought the laborers so much into contact with each other that unions were easy to form. The weakness of employers as a class has enabled unions to gain most of their demands. This success in turn has encouraged new members to join the unions and instigated the formation of still other unions connected with the craft. The shoe business has become so highly organized upon its labor side, and the unions have been able to dictate terms so completely that some employers, especially those who have large factories, have found their situation most irksome.

Of late years, therefore, there has been a distinct movement of corporations away from organized shoe-making centers into towns where the manufacture hitherto was unknown. For example, Lynn had 104 shoe manufacturers in 1920. Before 1924 no less than 40 had liquidated or failed, and 23 moved. In Haverhill, which had 122 enterprises in 1920, there was a loss by liquidation and failure of 67, and a removal of 23. Lynn in the period gained 51 new enterprises and Haverhill gained 66, but there was a net loss in number of 16 for Lynn and 24 for Haverhill. Since the firms lost were old and large, and the ones gained were young and small, the situation was serious.

The unions have been most aggressive in Massachusetts. There they have gained an 8 hour day and in some plants a 45 hour week. There, also, hourly rates are the highest for shoe workers. They have indulged in frequent unauthorized strikes, and prolonged the settlement of disputes, and they have taken out of employers' hands the power to hire and fire at will. As a consequence the labor cost per pair of shoes was in 1927: for

Massachusetts, 89 cents; for Maine, 56 cents; for New Hampshire, 58 cents. These figures tell why the firms that have moved have forsaken Massachusetts for Maine and New Hampshire. Manchester, New Hampshire, with 15 shoe factories, is one of the ten most important shoe centers in the United States, while Auburn, Maine, with 9 establishments, holds the 12th place in rank among shoe-making cities. Of course, the surcease from labor troubles gained by change of residence is likely to be short-lived, for the unions follow the industry.

Middle West Shoe Industry.—As the Middle West filled with people, business men questioned the economy of shipping western leather to New England and taking a return cargo of shoes in whose price was included the freight on both leather and shoes. To save these charges and to be ready to serve more quickly the expanding western market, shoe factories were started in each of the largest distributing points in the Middle West. Some were local enterprises and others were branch plants of New England concerns. St. Louis, Milwaukee, Chicago and Cincinnati all contested the supremacy of Lynn, Brockton, Haverhill and other Yankee cities. The command of raw materials, ready access to a constantly increasing market, and the saving of time as well as charges in shipments to retailers, caused the Middle Western plants to make serious inroads upon the former monopoly of New England.

St. Louis made the swiftest conquest of the far spreading market she served; indeed, her shoe manufacturers were not content with the natural market but invaded the East, going into New England itself, even the cities of Lynn and Brockton. In a score of years St. Louis rose in rank among shoe manufacturers from those listed as "All Others" to second place in numbers of workers, and third in value of products. In number of workers St. Louis in 1923 outranked every New England shoe city and yielded only to Brockton in value of manufactures. Except for New York City, whose pavement pounding millions call for 278 shoe factories within the city to supply the milling masses with footwear, St. Louis has become the leading shoe manufacturing city of the United States. It has 1,000 more workers than Brock-

ton, and the value of the shoes made is within a half million of that New England City.

Another place whose rise has been phenomenal is Milwaukee. Twenty years before 1927 it was seldom mentioned when shoe manufacture was discussed, but it has nosed ahead of all its mid-western rivals except St. Louis and all national competitors except New York, Brockton, St. Louis and Haverhill. It has surpassed Lynn. New England has not only lost relatively but absolutely in shoe manufacturing. The ten years following 1914 witnessed an increase of 20% in the national production of shoes, while those same years disclosed a falling off in New England shoe output of 17%. In 1914 New England made 53% of the shoes of the United States, but in 1923 her share had sunk to 37%. Within New England, Massachusetts has been the heaviest loser. Whereas the average labor cost per pair of shoes was 89 cents in Massachusetts, it was 53 cents in Missouri. The average weekly earnings of shoe workers in Massachusetts exceed by 6 dollars those of Missouri. From the point of view of labor, the Massachusetts standard is the more desirable, but in the relentless battle for markets the Massachusetts labor situation has been a competitive hamstring. In the long depression that settled over the shoe industry after the World War, particularly from 1921 to 1925, New England acutely suffered, whereas the midwestern industry expanded. In both Missouri and Wisconsin the business doubled after the war, but it declined in New England except for Maine, a state that gained much that Massachusetts lost. Yet, he who predicts the collapse of the shoe industry in New England is unwise. The long experience of managers and workers, the high quality of workmanship, and the originality of style in New England will hold the shoe industry there as an important local and national asset. The New England shoe industry is mature but not senile.

Changes in Size of Shoe Plants.—Although the unusual ease with which shoe manufacture may be begun has kept the scale of manufacture small as compared with other industries, this one, too, has evidenced a tendency toward larger scale operation. If classified according to value of output the number of plants pro-

ducing \$20,000 or less per year has shrunk. In workers and value of output this smallest class has remained stationary. On the other hand, the medium-sized factories, with products ranging from \$20,000 to \$500,000 have increased in number, wage earners, and value of output. Those in this class, with the largest values of output, have expanded the most. A similar statement is true with regard to plants whose output value was between \$500,000 and one million. The very large enterprises, with products of over one million dollars, have had a history akin to the smallest; they have fallen off in numbers, in employes, and value of product. The normal size of a modern shoe factory is one with a product valued from \$100,000 to \$500,000.

International Shoe Company.—The largest shoe manufacturing company in the United States—and in the world—is one that has resulted from a series of mergers and purchases. The International Shoe Company was born at St. Louis in 1898. It was a merger of the Peters Shoe Company—whose business was started in St. Louis as early as 1863—and the Roberts, Johnson and Rand Shoe Company, of the same city. In 1912 the International bought the Friedman Shelby Shoe Company, whose business was then eighty years old. The W. H. McElwain Company, after ten years' success, got into a financial snarl in 1925 and sold out to the International. This action was condemned by the Federal Trade Commission as a violation of the Clayton Act. The International asked for a hearing of the case, which was not settled up to the time this was written.

The International Shoe Company controls 32 shoe factories in Missouri, 10 each in Illinois and New Hampshire, and one in Kentucky. The daily capacity of these factories is 180,000 pairs of shoes and in 1926 no less than 47 million pairs were made. In addition to the shoe factories the International controls 9 tanneries which furnish 75% of the sole leather used by the company's shoe factories. An extract plant and a factory capable of producing 125,000 pairs of rubber heels per day also belong to the company. For sales branches, the International is provided with 5 houses in St. Louis, two in Manchester, New Hampshire, and one each in Boston and New York.

The company has been well managed and has had an uninterrupted record in the payment of dividends, both preferred (6%) and common stock (\$6 to \$7 per share). Its financial strength has been and is exceptional.

Endicott Johnson Corporation.—The second largest shoe manufacturing concern is the Endicott Johnson Corporation, of Binghamton, New York, or rather of two suburbs of Binghamton, Endicott and Johnson City. In 1894 Henry B. Endicott purchased controlling shares in the Lestershire Manufacturing Company, of Lestershire, later called Johnson City. George F. Johnson becoming associated with Endicott, a Maine charter was secured for Endicott Johnson Company, which in 1909 was changed into a co-partnership named Endicott, Johnson and Company. In 1919 the partnership again incorporated under the name Endicott Johnson Corporation.

This corporation owns 5 shoe factories, one tannery, a rubber sole and heel factory, departments for manufacturing findings (eyelets, etc.), a number of retail stores, and a water works. It has 3 distributing houses located at Endicott, Jersey City, and St. Louis.

The capacity of the shoe factories—all located within 5 miles of Binghamton, except one 12 miles away at Oswego—is 130,000 pairs of shoes per day. The rubber factory turns out 125,000 soles and 100,000 pairs of heels per day.

The corporation attributes its unusual success to a liberal labor policy. The workers have a stake in the concern for after 7% has been set aside for preferred stock and 10% for common stock, the balance of the net earnings are shared equally between the workers and the holders of common stock. As the retirement of preferred stock is a charge upon the business, eventually the workers will be more generously rewarded. Each worker shares equally; that is, the distribution is per capita, not, as is generally the case with profit sharing schemes, in accord with wages.

Other Large Companies.—The third of the large shoe manufacturing companies is the Brown Shoe Company of St. Louis.

This business, which started in 1879, has 5 factories in St. Louis and 2 others in Missouri, 6 in Illinois, and one each in Tennessee and Indiana. It also possesses its own tannery, at Gowanda, New York, but not enough leather is produced to meet all the requirements of the parent company. A half dozen well known trade-marked brands of shoes are made by this company. Its preferred stock dividend has been paid regularly, but after paying a large stock dividend in 1920 the dividend on common has been irregular.

In New England one of the largest companies is Rice and Hutchins, an old concern making shoes for men, women and children. Its "Educator" line is well known. Another large business, with headquarters at Brockton, is the George E. Keith Company, makers of the Walk-Over shoe. This company, like Endicott Johnson, owns and operates a chain of retail stores besides selling to other retailers.

Style in Shoes.—One of the factors that has prevented shoe manufacturing from reaching large-scale proportions has been the inclusion of style in shoes. Although this has been most noticeable in women's shoes, it applies also to men's. The style features have been shape and color. The number of styles has been legion and shifts have occurred as rapidly as from month to month. The women's shoe business, both in manufacture and retail branches, has acquired many of the characteristics of millinery. Under these circumstances risk has been excessive and failure or loss appalling. On the other hand, style has unquestionably promoted sales.

Medium-Priced Field Offers Greatest Opportunities.—The large companies to which reference has been made have chosen the market that awaits medium-priced shoes. In this field style is not so important and a modicum of standardization possible. It is because so many New England shoemakers have produced women's shoes that that section is the home of many small-scale shoe factories in which the turnover in ownership has been rapid. In American manufacturing history generally it has been the standardized output of an article for the masses that has been

crowned with success. This factor accounted for the early supremacy of New England shoemakers, and now is a prominent feature of the modern leaders in the Middle West. Since social custom demands the wearing of footwear, and inasmuch as American wages are sufficiently big to permit the purchase of shoes, the market for shoes is assured. Despite the national surplus productive capacity, by efficient management a factory producing medium-priced footwear is certain to be reasonably profitable to its owners.

CHAPTER XX

PAPER MANUFACTURE

Introduction.—To the Chinese the world is indebted for the modern method of making paper. It was in China about 100 A. D. that rags were pulped and the fibers felted to form a sheet; yet the Chinese records indicate that the idea may have been suggested in India 200 years before the Chinese made practical use of it. Block printing and movable types were invented in China about 1000 A. D., so that the Chinese masses had printed books selling for the equivalent of 1 cent to 150 cents fully 500 years before Guttenberg, Faust and Schoeffer, by their inventions, stirred political and religious turmoil in Europe and created a demand for paper manufactured in the Chinese manner.

The Arabians, who were responsible for passing many Oriental arts and crafts into Europe, were the agents by whom Europeans became acquainted with both Chinese paper and Egyptian papyrus, although the latter was popularized by Romans. Native European parchment made from the skins of young calves, lambs and goats was more common than papyrus in Europe. The production of papyrus being simpler than that of paper, the former preceded paper except in China, and was developed not only by the Egyptians but far to the east. Captain Cook, in his personal record of his memorable voyages to the islands of the south Pacific, mentioned conspicuously a native material the manufacture of which, according to Cook's description, corresponded exactly with the Egyptian papyrus. Tourists in modern Hawaii, where Cook died, are sold tapa cloth which the natives have produced for unknown ages by the same methods employed by the Egyptians in making papyrus.

The first Europeans to become expert in making paper by the Chinese-Arabian process were the Spaniards. From Spain, after 1000 A. D., the craft seeped northward and eastward to Holland,

Flanders, France, Germany and Austria. The Germans were the chief heirs of Spanish paper-makers. The first paper *mills* appeared in Germany in the 14th century when the expansion of trade and commerce created a demand for writing materials. It was one hundred years later before the British experimented with paper and then its manufacture there made slow headway, partly because the British dressed in leather and wool—and so had few rags for paper-makers—and partly because the British then lagged industrially and commercially behind continental principalities.

At the time America was settled the British imported from Germany, France and Holland most of the paper they used. Hence British colonists in America could not reproduce in this country an art with which they were unfamiliar at home. It was a German who built the first American paper mill.

The First Paper Mill in America.—William Rittenhouse, born in 1644 near Mülheim on the Ruhr, came of a family that for generations had been paper-makers and prominent in public affairs. Rittenhouse, a Mennonite minister, emigrated to America by way of Holland in 1688 and settled in the Germantown suburb of Philadelphia, acting as the first Mennonite bishop in America. Coming in contact with William Bradford, a Philadelphia printer who was too energetic for that city and so removed to New York, Rittenhouse and Bradford formed the first of a great many associations between paper-makers and printers. On the banks of a little stream that emptied into Wissahickon Creek, about two miles above the junction of that winding waterway with the Schuylkill, Rittenhouse in 1690 built the first paper mill in America. Bradford, who if living today would be a leading Rotarian, contracted for the entire output of the Rittenhouse mill and so until 1707 had a monopoly on all the paper made in America. The Rittenhouse family for three generations was active in manufacturing paper, and two of the generations had close business relations with the two corresponding generations of Bradfords.

The De Wees and Willcox "Ivy" Mills.—William De Wees, a native of Holland and a resident of New York City, became an apprentice to William Rittenhouse when De Wees' sister married

Rittenhouse's son. When De Wees mastered the art of paper-making he built, in 1710, a mill in Germantown, the second one in America.

The environs of Philadelphia saw a third paper mill in 1729, when Thomas Willcox, an Englishman, built the famous "Ivy Mill" on the west branch of Chester Creek, twenty miles southwest of Philadelphia. There for 98 years three generations of the Willcox family manufactured paper, some of it for Benjamin Franklin, a close friend of the first Willcox. After 1775 the mill was especially noted for the production of paper for the government, which used almost exclusively the output of this mill for paper currency. States and individual banks were also customers of the Ivy Mill.

The Milton Mill.—Between 1639, when the first printing press in America was set up in Cambridge, Massachusetts, and 1728, there were 23 print shops in Boston, 9 in Philadelphia, and 2 in New York. Three paper mills served the printers of Philadelphia, while Bradford, one of the New York publishers, had a mill at Elizabethtown, New Jersey, after 1728. But the 23 printers of Boston were without local producers of paper until 1728, when a mill was built at Milton. The backers of this project were Daniel Henchman, a wealthy bookbinder, bookseller and publisher; Henchman's son-in-law, Thomas Hancock, another bookseller and uncle of the famous Signer; Benjamin Faneuil, father of Peter Faneuil; Gillam Phillips, son-in-law of Benjamin Faneuil; and Henry Dering, a practical paper-maker who became superintendent of the mill. Paper was produced by this Milton mill for three-quarters of a century, during which time workmen trained in the mill left to set up mills of their own or to take charge of new mills; more than half of the New England mills during the life of the Milton mill drew upon it for experienced men.

Pennsylvania Leadership.—At the time the Milton mill was built, four of the six American newspapers were published in Boston, two-thirds of the books and pamphlets were issued by Boston printers, and in number of printers Boston boasted more than twice as many as any other place. Yet Philadelphia had a

paper mill 38 years before Boston, and had three before Boston had one. This disparity continued, for in 1769 there were 40 mills around Philadelphia to three near Boston, and in 1787 out of a total of 63 mills in America no less than 48 were close to Philadelphia.

For this strange situation there were several explanations. Foremost among them was that in the 17th and 18th centuries the British were much less versed in paper-making than the Germans, so that it was natural for paper manufacture to rise first in America where the Germans were most thickly settled. The German immigrants were principally religious refugees whose tenets were similar to those held by the Quakers; consequently William Penn's colony became a sanctuary for the whole eccentric group. The German craftsmen taught paper manufacture to the other Pennsylvanians. Since the art was almost entirely manual and required the highest skill, paper mills were inhibited except where the craftsmen were available.

Philadelphia not only had the largest supply of skilled labor, but also possessed the greatest amounts of raw material, namely, linen and cotton rags. In New England, because of the colder climate and British habits, the people clothed themselves more generally with wool and leather than linen. On the contrary, in Pennsylvania the warmer climate permitted a more liberal use of linen and also the Germans came from flax-growing, linen-using sections of Europe. Before coming to America they had learned to save every scrap of linen material for the paper-makers. Paper in colonial America and for many years after Independence, was made exclusively of rags, but at no time were the mills provided with sufficient rags. Consequently, the most familiar feature of paper-making was the constant plea of the manufacturers for the public to save its cast-off linen wearing apparel. The dearth of rags was the limiting factor in paper manufacture for a century and a half.

Scarcely less influential in the promotion of paper manufacture in Pennsylvania was the energy of certain individuals. William Bradford, a forceful far-seeing man, was backer of Rittenhouse and De Wees. The more famous printer, Benjamin Franklin, was said to have shared in the beginnings of 18 paper mills.

A negative factor in hindering the erection of paper mills near Boston was the ease and relative cheapness with which Boston publishers could furnish themselves with imported paper brought into port by Boston's commerce carriers.

Other Colonial Mills.—In addition to the large cluster of mills near Philadelphia and a smaller one close to Boston, paper mills at the opening of the Revolution had been started in Connecticut, New York, Maryland, Delaware and North Carolina. Although the production did not keep pace with consumption, much of the paper compared favorably with that produced at the time in Europe. The quality of paper depended upon the care with which rags were sorted, the cleanliness of the water, and the deftness of the workmen. Since machinery had not entered the industry, small-scale production was the rule throughout the world. On the side of quality we were at a slight disadvantage as compared with Europe, but the scarcity of rags limited the output of existing mills and prevented the erection of others. The British hampered our colonial paper manufacture scarcely at all. They themselves were not far in advance of us in this industry. Their own needs were met largely by imports from the Continent, so they could not object validly to our attempt to supply our own wants. Our few mills were no threat to theirs.

Paper During the Revolution.—The limitation of quantity of paper because of the shortage of raw material in America was a serious matter during the Revolutionary War. The war shut off imported raw material and the enemy held the big towns of Boston, New York and Philadelphia; yet the colonial army officers needed paper for their orders and the public was extraordinarily interested in pamphlets and news-letters. People were forced to curious makeshifts to enable the scant supply of paper to fulfill the needs. The margins were made to carry three and four lines of printing, and old sermons or pamphlets that had utilized only one side of a sheet were collected and printed on the back. Paper torn in transit from the mills was carefully and skillfully patched; in short, every scrap of paper was made to do full duty. To encourage paper manufacture the employes were

exempt from military service and even prisoners of war, particularly Hessians versed in the art, were sent to the mills to make paper. But rags were the limiting factor; paper could not be produced without them and the supply was exceedingly restricted.

There was not only a paucity of rags but also of moulds, the wire that fitted the base of moulds, and the felt between which the sheets were pressed. The civil and military officials throughout the war went to unusual lengths to hide these accessories from the British and to favor workmen who knew anything about the making or repairing of this equipment.

Following the Revolution.—The number of paper mills, which had increased but slowly before the Revolution, did not begin to mount rapidly until after the Constitution was adopted. When Cornwallis surrendered there were probably about 80 active paper mills in the country. At the close of the century the number may have been 100. When the census was taken in 1810 an attempt was made to gauge the industrial strength of the nation but the result was woefully inadequate. An analysis of the census results published by Tench Coxe placed the number of paper mills at 202, which, if true, was a doubling of the count within 10 years. The survey disclosed that Pennsylvania, the original seat of the industry, was still the leader in number of mills, reams of output and value of product. But it revealed that New England had risen alongside of Pennsylvania and that the mills in the North were about twice the average capacity of those in Pennsylvania. Massachusetts and Connecticut had distanced the other New England States. New York had added greatly to her number of mills although most of them were of small capacity. Another feature of the report was the proof of the manner in which paper-making had spread in the states where formerly no mills had been; for even the new districts of Kentucky, Tennessee and Ohio had paper mills. In short, paper manufacture was no longer localized in Pennsylvania but was a small-scale local industry almost everywhere. Its greatest concentration was near the four newspaper and book publishing centers of Boston, Hartford, New York City and Philadelphia.

Massachusetts, which was second to Pennsylvania, had four

nuclei for which paper-makers were beginning to show a decided preference. These were the regions close to Boston, Worcester, Springfield and the Housatonic River Valley within the Berkshire Hills.

Scarcity of Raw Material.—The ancient complaint of the paper manufacturers at the public's indifference to saving rags was reiterated from the Revolution to the Civil War. In the earlier years of the 19th century the lamentation was bawled fortissimo, but as domestic transportation facilities were improved the clamor lessened to a mutter, and finally to a scarcely perceptible murmur. Newspapers and leaflets in the opening years of the century bore advertisements of the paper-makers, beseeching the saving of rags. These advertisements appealed both to the "pocket nerve" and to the heart, for they offered cash and special prizes to the savers of rags, and hinted to maidens that swains could not write billets doux unless the maids aided the paper-makers. Bachelors were warned to save rags, for if they did not, designing mothers and simpering spinsters would call upon the single blessed in person instead of sending written messages. Fetching appeals such as these were printed both in prose and in verse. But they had inadequate effect until systematic house to house collection of rags was inaugurated.

The importation of rags began with the century and mounted with the years. This added supply aided principally those mills near the Atlantic Coast, for inland transportation was too expensive to warrant the carriage of waste materials for any distance.

After 1814 the industrial revolution in cotton manufacture added to the raw materials for paper, as the clipped pieces of cotton cloth and the fibers wasted in spinning were gathered and shipped to nearby paper mills. Indeed, the clean clippings from cotton factories and other mills which manufactured articles from cotton cloth became the most prized raw material for the paper-makers.

As long as rags were difficult to get, paper mills were scattered so as to avail themselves of the materials in every district. Moreover, the restriction of raw material in any one region prevented the paper mills in that territory from attaining great size. The building of canals and especially the construction of

railroads brought relief to paper manufacturers because the improved transportation made it easier to assemble raw materials, to collect them over wider areas, and to gather greater quantities. But this assistance did not do more than offset the increased demand for paper that came with larger population, greater circulation of newspapers, and higher-g geared industrial, commercial and business enterprises, to say nothing of the technical improvements within paper mills themselves. Raw materials of a new kind less restricted than rags finally became imperative for paper manufacturers.

Skilled Labor.—Skilled labor, the shortage of which was twin to paucity of rags in shackling paper manufacture before the Revolution, was a factor of declining importance through the first half of the 19th century. Each small mill became a school for teaching labor, until a large body of trained men was available. The paper workers acquired characteristics similar to printers; they were a restless, wandering set of men. With mills sprinkled over the land, the workers were sure of jobs most anywhere, so they worked for a while in one mill and then took to the broad highway until they reached another mill. They became as noted for their skill with the tankard and thin stemmed glass as for their deftness in forming a sheet with the paper mould. When the paper-making machines were placed in factories they did not cure paper workers of their vagabondage until the generation that knew the old ways yielded to the youngsters who never had experienced the romany trail.

Capital.—Since paper-making was manual it could be begun with small capital. For about 150 years a capital of less than \$5,000 sufficed to begin the business. No power was necessary in the earliest mills, for it was possible to pulp the rags with hand wielded mallets, but this was so slow a process that most of the original mills used water power to aid the pulping. The cost of this power and the vat were the principal items in the capital requirements. In addition there were moulds and a hand-press, a building to house this equipment, and a loft to dry the sheets. Larger-scale production was attained by doubling or tripling the

number of vats but it was a rare case when the capital investment exceeded \$20,000. After machinery was introduced this easy situation regarding capital was changed; the capital requirements mounted until paper manufacture in proportion to the value of its product became one of the most capitalistic in the country.

Hollander and Jordan Engine.—The time honored method of manufacturing paper was to sort linen and cotton rags into those that were clean and white—for white paper—and those that were dirty and dyed, for colored or cheap papers. The rags were fermented and at the proper stage were beaten in a mortar to a pulpy mass. This pulp mixed with water was stirred in a vat (tub) so the loose fibers would interlace and felt. The paper-maker dipped a wire-bottomed frame—somewhat like an ash sieve—into the pulp and lifted it from the vat, draining the excess water through the wire mesh, while he shook the frame so as to product an even body of pulp. This was carefully turned out on a felt mat and covered with another felt. A pile of alternate felts and pulp were placed under a hand screw-press and the water squeezed out. The felts were removed and the sheets hung in an airy loft to dry.

The first aid in this process was the substitution of a set of stampers driven by wind-mills or waterwheels for the mortar and pestle. This crude pulping machine about 1750 was superseded by the “Hollander”—named from the supposed country of its origin—which was an oval vat in which rags and water circulated past two sets of knives, one mounted on a wheel, the other on the floor of the vat. The rags passing these knives were torn and shredded to fibrous pulp. Wind-mills, waterwheels, and eventually steam engines furnished the power to operate the hollanders.

The hollanders relieved paper-makers of one of their most repugnant tasks and at the same time furnished ample stocks of pulp. Under the older methods of pulping, the paper-maker was often interrupted by insufficiency of pulp. The hollander, or beating engine, appeared in American mills almost as soon as in Europe. Although the details of the machine have been greatly

refined, the essentials of it have never been altered since the first one was installed.

After paper-forming machines were invented Americans added a second beating engine—called a Jordan—to the hollander. The Jordan gave to the pulp a more uniform consistency and cleaned it more thoroughly than the hollander.

Cylinder Machines.—Hollanders merely prepared raw materials. In America the first machines to replace the hand paper-maker were cylinders which dipped into pulp vats, took up the pulp by an arrangement of wires and felt, squeezed out the excess water, and passed the partially formed paper along to rolls which did the work of the former screw-press. In time, rolls heated by internal fires and then by steam were placed in line with the cylinder and press rolls; these heated rolls took the place of loft-air-drying.

The first cylinder machine invented in America was the brain-child of Thomas Gilpin, one of two brothers who for fifty years operated a paper mill on the Brandywine near Wilmington, Delaware. In August, 1817, Gilpin put his cylinder in operation and ran off what is generally credited as being the first machine-made paper manufactured in this country. The machine produced paper in a continuous band of any desired length instead of single sheets as was the case with hand-made paper. Not only was the cost of making paper greatly reduced, but so was the time required to turn it out. Moreover, the quantity was much augmented.

Naturally, the Gilpins took every precaution to keep their machine a secret, and during the three or four years they succeeded in doing so, a golden stream to their coffers matched the endless flow of paper from their machine.

But the news of Gilpin's methods began to seep through the paper trade. Other paper manufacturers, foreseeing doom unless they could get a Gilpin machine, and visioning a glittering reward if they did procure or invent one, tried every means fair and foul to pry into the Gilpin secret.

The manufacturer who first succeeded in emulating the Gilpins was John Ames, who with his brother David, owned and operated one of the largest paper mills in Massachusetts, at Springfield.

Living in a time when business ethics were not high, these brothers had the reputation of not letting scrupulous conduct interfere with garnering money. They were accused of using underhand tactics in securing knowledge of the construction and operation of the Gilpin machine. John, who was the more inventive of the two brothers, in 1822 patented a cylinder machine which, although it repeated the fundamentals of the Gilpin machine, was much superior.

With the Ames machine the brothers extended their paper-making enterprise and in turn endeavored to shroud their invention with obscurity. But a rival hired an Ames foreman and soon the rival had a cylinder machine in his plant. Litigation between this rival—Howard and Lathrop of South Hadley—and the Ames, and between the Ames and Gilpins, not only well-nigh ruined all the parties concerned, but gave such publicity to the inventions that infringement of patents was constant, as other paper-makers stole the ideas of the litigants.

With cylinder machines rapidly replacing handwork, inventors applied their wits to improving the details and then incorporating further mechanical appliances to place in line with the cylinder, so that the entire process from wet pulp to dry-finished paper, cut to size, could be done in one mechanical train. The first complete paper machine was manufactured by Phelps and Spafford, of Connecticut, and placed on the market in 1830.

Fourdrinier Machine.—Meanwhile in Europe paper-makers had preceded Americans with machines, an Englishman having invented a cylinder in 1809, eight years before Gilpin operated his machine. But ten years before the English cylinder machine was installed, a Frenchman had solved the problem of mechanical production of paper. His original ideas are now incorporated in a machine that has surpassed all cylinder machines, whether British or American.

This ingenious French paper worker was Nicholas Louis Robert. Lacking funds for exploiting his machine, he turned for help to the publisher, St. Leger Didot. The latter in turn called upon his brother-in-law, John Gamble, who took Robert's ideas across the Channel to Henry and Sealey Fourdrinier, wealthy

wholesale stationers. These brothers spent \$300,000 in perfecting the machine and brought it to such a completion that the machine since has never been radically improved. Robert, Didot, Gamble and the Fourdriniers all were bankrupted before the machine was finished. Eventually, Robert was granted about \$2,000 by the French government, and in 1840 the British gave \$35,000 to the Fourdriniers. The latter, too, have been distinguished by having their name permanently fixed to the most fundamental machine in paper manufacturing.

The Fourdrinier machine performed all the work of forming and finishing paper from the pulp to the salable product. The machine was marketed in England as early as 1803. Ten were sold in Britain during the next ten years, and 25 more in the succeeding decade. In America the Fourdrinier was unknown to Gilpin and Ames when they invented their cylinders, and only vague rumors of the Fourdrinier had reached this country up to 1825. It is supposed that the first Fourdrinier in the United States was imported in 1827 by Henry Barclay, of Saugerties, New York, and was set up in a mill owned by Beach, Hommerken and Kearney. This original machine was run for 45 years. American machinery manufacturers began to produce Fourdriniers in 1829 but for many years parts of the machine were imported. It was not until the Civil War that the machine with all of its accessory equipment was manufactured in this country. The Fourdrinier became the pivotal mechanism in paper-making factories.

It was so very large and expensive that few paper mills had more than one, and its capacity was so great that even one machine could produce from 10 to 20 tons of paper per day. As late as 1923 the 746 paper mills in the United States had but 955 Fourdriniers installed. However, many mills had no Fourdriniers, while the largest mills had several. In 1927 a single Fourdrinier might cost from \$250,000 to \$500,000.

Slow Change to Machinery.—Although cylinder machines were available after 1825, and Fourdriniers after 1830, the machines were but slowly accepted by American paper-makers. Although the conservation of a long-rooted hand trade opposed the

introduction of machinery, this factor should not be overemphasized.

Since the new machines were costly and inasmuch as most of the paper mills were small-scale, it was a rare paper-maker who could afford to plunge into the installation of mechanisms whose first cost often exceeded his entire previous capital investment. At that time the machines were unproved, so that the profit in their use was speculative.

Then, too, machines necessitated the pulping of more raw material than most localities yielded. It was not until after 1830 in the Northeast, and later than that elsewhere, that railroads made it possible for any one mill to tap the raw material resources of distant regions. Even after the railroads widened the area from which raw materials could be gathered, as long as rags were the principal ones, paper-makers hesitated to invest in machines that had a voracious appetite for rag pulp.

Finally, and most important of all, paper production for four hundred years had been sensitive to the demands of printers. Hand-printing presses were not brought to perfection in America until 1829 and then the best machine with two operatives turned out but 250 sheets per hour, printed on one side. The *London Times* for November 28, 1814, was the first issue of any newspaper from a power printing press, and it was 1822 before a power press was installed in the United States. Hoe did not introduce his cylinder press, capable of printing a continuous sheet, until 1840. No type casting machine was invented here until 1838, and it was after 1890 that the linotype was introduced. The type-writer for business correspondence did not appear until after 1880. That is to say, the principal markets for paper in the publishing industry and demands of business houses did not exert undue pressure upon paper manufacturers until after paper-making machines were invented. The greater productivity of these machines was not called upon to supply a real need until after 1840, and it was not until forty years later that the market for paper became avid for the product of mills.

Hence, paper manufacture by hand continued in the United States until 1920, and a few hand craftsmen still ply their art in

Great Britain. But after 1840 machine-made paper dominated the industry, both in this country and abroad.

Search for Raw Materials.—The coming of machinery into the paper industry intensified the restriction placed upon manufacture by the scarcity of rags. Although railroads brought to the mills tons of rags, where pounds had hitherto had to suffice, the increased supply of rags barely kept abreast of increased consumption of them by paper-makers. A substitute for rags became imperative.

It is possible to manufacture paper from any fibrous vegetable material; in truth, no less than 500 different things have at some time or place been so employed. But the range of commercially practicable raw materials is limited by several economic considerations. First, the substance must not contain chemical compounds that make pulping, bleaching, dyeing, and "sizing" (surface filling) difficult; second, the paper resulting from the raw material must be reasonably durable; third, there must be no competing use for the fiber—for example, cotton fiber, although an excellent raw material for paper, is too valuable for the manufacture of cloth to permit its use directly in paper manufacture; fourth, the fiber must not be difficult to extract; fifth, there must be a large supply near a market; and sixth, the material must be cheap.

These essential factors confine the practicable raw materials to a narrow field. Those that were first substituted for rags were old rope, straw and waste paper. Of these the one that seemed to be most promising was straw. Between 1840 and the Civil War many mills in New York State and some in the Middle West specialized in making paper from straw. While wrapping paper and cardboard were the principal products of straw, experiments frequently were made to produce newsprint paper from straw. These were disappointing.

Wood Pulp.—Spruce, hemlock and poplar sticks can be ground on a stone, reduced to a pulp, and manufactured into paper, a mechanical process of making wood pulp that was discovered before 1800 but not developed until after 1840, when the need of a substitute for rags became increasingly urgent. The idea is said

to have originated from observations on the building of wasps' nests. Paper made from mechanical pulp is very weak because its component fibers are so short, a fact that led to the perfecting of chemical processes for the procurement of wood pulp. By these processes the wood is first chipped, then put into a tank containing either acid or alkali which eats out the organic matter in the wood and leaves behind the fibrous cell walls. After the excess acid or alkali has been removed the fibers are pulped and made into paper.

Mechanical pulp is easy and cheap to make but lacks strength, whereas the chemical pulp, although harder to manufacture and therefore more expensive, results in much stronger paper, since strength is determined by length of fiber. Consequently, for most paper a mixture of the two varieties of pulp is used; for newspapers, as an example, the composition is 70% mechanical and 30% chemical pulp.

Although mechanical pulp eventually dominated the industry quantitatively, the chemical process was the first to be tried in America. Hugh Burgess—an English inventor and immigrant to America—in conjunction with Morris L. Keen, started the manufacture of soda pulp paper in mills constructed for that purpose at Royer's Ford and Manayunk, both in the environs of Philadelphia. The business in 1863 was organized as the American Wood Paper Company. The soda process used by this pioneer enterprise has since been supplemented and surpassed by the sulphite and sulphate processes.

Mechanical pulp was introduced to America by the brothers Albrecht, Alberto, and Rudolph Pagenstecher. These men studied the German methods where mechanical pulp had been brought to some success and then, in 1867, erected a small experimental mill in Curtisville, near Stockbridge, Massachusetts. From this tiny two-story shed-like factory the mechanical pulp industry has mounted to gigantic proportions, the output being weighed in millions of tons per year.

Revolutionary Effects of Wood Pulp.—The use of wood pulp revolutionized the paper industry. It caused a new classification of paper according to use and raw material; it made one sec-

tion of the industry highly capitalistic and large-scale and changed the location of plants; and it brought about international complications.

Classification of Paper by Use and Material.—The greatest consumers of paper have been the publishers. Of these, the leaders by a wide margin have been the newspapers. Except for certain special editions newsprint paper is made entirely of wood pulp. Hence, the demands of newspapers and the supply of newsprint are by far the most important factors in the paper industry.

Publishers other than news are those that produce magazines and books. For them "book paper" is made. "Book paper" for magazines is generally made from wood pulp but the proportion of chemical to mechanical pulp is higher than for newspapers and much more care is devoted to the finishing of such papers. Several magazines exceed a demand for 10,000 tons of paper a year. The publishers of books may use paper similar to that on which magazines are printed or may purchase paper in which rags are added to wood pulp.

"Fine paper," which is the third class, is that intended for writing, bank notes, securities, and the preservation of records. This paper varies in content. There is little, if any, mechanical pulp in it, but some grades of fine paper are wholly chemical pulp. The best grades have none or very little, if any, wood pulp but are composed of rags. Papers that are all rag stock are graded according to the kinds of rags used.

Wrapping paper is made from a variety of materials and hence has many grades. Wood pulp, old rope, straw and waste paper all enter into various grades of wrapping paper.

Paper boards are composed of the same varieties of materials as wrapping paper. Building papers likewise use these materials but some are made from bagasse (sugar cane refuse) and cornstalks. Tissue paper in its composition ranges from old rope, used for jewelers' tissue, to that which has a high content of mechanical pulp.

This variety of classes has been brought about by a wider range of raw materials; narrow limits were necessary when rags were the only materials available. Paper may be made with marked

differences in quality to fill demands equally at variance. The sheet whose use is for the moment may be made cheaply from low-priced materials, while the page that must be preserved is made from the strongest, most durable and most expensive materials. Fortunately the greatest demand is for the most ephemeral paper, so that the largest volume of paper may be manufactured from the cheapest materials.

Capitalistic Nature of Wood Pulp Production.—To manufacture wood pulp by mechanical grinders requires from $66 \frac{2}{3}$ to 100 horsepower per ton of wood. Since we produce between 2 and 3 million tons of mechanical pulp it is apparent that the demand for power is large in this branch of the paper industry. Taken with other factors water power is the cheapest form of power for pulp makers. Consequently, the mechanical pulp mills had to seek the best water power sites. These were found in the remote sections of New York, Maine, New Hampshire, Vermont, Wisconsin and Michigan. To buy and develop these sites took much money.

Since a pulp mill was limited to large power sites and inasmuch as a cheap variety of paper was being produced it was requisite to install the longest, widest, fastest-running Fourdriniers. These cost up to \$500,000. The mill with this equipment was a large, costly affair, so it had to be located permanently. Hence only a region where immense tracts of spruce, hemlock and poplar promised plentiful raw materials for a long time in the future could be considered for manufacturing pulp. A crop of trees, unlike cotton or flax, is not a matter of one year's time, and to insure a future supply of raw materials, pulp makers had to become heavy investors in forest land.

In 1800 a paper-maker could commence operations with a capital investment of \$5,000 or less; but in 1900 the man who proposed to manufacture paper from mechanical pulp had to have command of $1\frac{1}{2}$ million dollars, and the more he exceeded that figure the more secure he was. The makers of chemical pulp, although released from the requirement of large water powers for their preliminary processes, nevertheless needed great power to run their beating engines and Fourdriniers or cylinder machines.

In most respects, therefore, this business was hardly less capitalistic than the mechanical pulp branch. The mills making fine rag paper, and those producing straw paper, were freed from heavy investments in raw materials and machinery for converting this raw material to fiber prior to beating. But the remaining processes of manufacture were thoroughly mechanical and the machines were expensive. So these branches of paper manufacture also were capitalistic.

Large-Scale Production.—Excessive capital requirements in industry generally have been conducive to large-scale production. The newsprint and book paper mills have well exemplified this association for the characteristic enterprise in these branches has been large-scale.

Most of the plants making fine papers followed the tendency toward large-scale production, but since this was the oldest branch of the paper industry individual enterprises here and there remained relatively small. These smaller plants emphasized quality rather than quantity of output. Some of them specialized on certain unique papers such as that used for banknotes.

Although it is truthful to say that paper manufacture became characteristically large-scale when it became capitalistic, there is one exception to be made. Those mills whose raw materials were waste products, such as colored rags, waste paper and old rope, continued to depend largely on their neighborhood for supplies. These being limited, the mills did not expand. Little paper mills, therefore, in 1927 were scattered over the nation just as they were a hundred years earlier at the dawn of the new era. Some of these mills were unbelievably tiny; a few were operated by one man alone with no hired help; others had a half-dozen employes; while most of them had fewer than 20 men engaged. In 1919 there were four mills with a product valued at less than \$5,000.

As a whole about two-fifths of all paper mills in 1923 were large enough to produce more than one million dollars each in products. About one-fifth had products valued between a half million and million each; while less than one-tenth were small mills each with a product valued at less than \$100,000.

Location of Mills.—While small paper mills were scattered over the nation before wood was found to be a practicable raw material, the mills were not located at will, for certain metes and bounds clamped them. The mills were most numerous or largest near the publishing centers. From the day of Rittenhouse always there has been a close association between printers and paper-makers. The definite plan for a mill was determined by a stream with ample supplies of clean, soft water at a power site. But a stream was neglected unless a mill placed upon it could easily secure rags and other paper stock and the finished paper could, without undue expense, be shipped to printers and stationers.

Among the regions that attained more than a local reputation was the upper Housatonic Valley between the Berkshire Hills in western Massachusetts. The pure water and clean air of the valley caused a concentration of paper mills at Dalton, Lee and adjoining villages. These places became famous for the quality of paper produced and were on the way to undisputed leadership for quality product. Although some of the best paper made in the United States down to the present day is produced in the Berkshires, leadership passed to the Connecticut River Valley.

In the middle of the 19th century the general use of cylinder or Fourdrinier paper machines put a premium upon power as well as upon purity of water. Since the machines were for the final steps in manufacturing, their introduction required a speed and enlarged capacity in the preliminary pulping mechanisms. To operate all this machinery called for more power than the little streams hitherto chosen by paper manufacturers could furnish. The newer larger mills sought the larger rivers. In New England the Connecticut is the mightiest waterway. At South Hadley Falls it dropped 70 feet within two miles. This fall together with the volume of the river and the fact that the stream curved so as to make power utilization easy caused promoters, in 1847, to build a great timber dam 30 feet high across the Connecticut so as to divert a large volume of water through a series of canals. For a generation this dam was the central feature in the largest and most daring water power project in America. The timber dam was improved in 1870 and in 1900 was replaced with one of solid granite.

The power promoters intended to create a textile city at the Falls comparable to Lowell and Lawrence, and as a matter of fact textile mills did locate there. But in 1853 the Parsons Paper Company put up its first mill in Holyoke—the city that rose at the Falls—and the advantages in the manufacture of fine paper drew many other paper-makers to the site. The largest power in New England was at hand, and the water of the river was found particularly well adapted for the manufacture of quality paper. Within a quarter of a century Holyoke became the largest producer of fine writing paper in this country and in the world. The Berkshire district was completely overshadowed in volume of product.

But the production of writing paper was and is relatively unimportant compared to the paper made for publishers of newspapers, magazines and books. When wood pulp became the reliance for newsprint and book papers the need to be near forests and to have extraordinary power facilities in order to safeguard the large capital investment drove these classes of paper-makers far from cities into the remote backwoods. The mountain areas of New York, the inland mountain and lake districts of Maine, northern New Hampshire and Vermont, and the northern forest frontiers of Michigan and Wisconsin, became the regions of paper manufacture. In tons of output these out-of-the-way places exceeded all the paper mills, big and little, that were closer to the throbbing metropolitan centers.

As a consequence, modern paper mills are located according to the kind of paper they make in one of three different sets of places. The great mills, producing newsprint, are far off the beaten track. Mills producing quality papers hug the cities as closely as consideration of raw material and power permit, while little mills making tissue, carpet linings, board and the like, are broadcast. Some large-scale mills producing the third type of paper (tissue, etc.) are in or near cities.

International Complications.—When manufacturers of newsprint and book paper forsook rags for wood as raw material, they virtually put reliance upon an extractive industry. That is, forestry as generally conducted in the United States is like mining ;

it exhausts a natural resource. While this need not be the case, and so far as paper is concerned is not true of certain companies, which plant their forest reserves as fast as they cut them, in the majority of instances the American paper-makers scythe the trees in windrows, leaving the land naked.

This policy is not altogether uneconomic for the land is thus cleared for settlement, and the mill investment after the forest has been removed, may be productive through the sale of power, although every paper machine stands idle for lack of raw material.

But the practice sets a definite limit to the time any forest region can support a paper industry. When the trees are gone, paper-making stops. After 1899 we increased our consumption of wood pulp about 200,000 tons a year. Foreseeing the eventual exhaustion of our own paper raw materials, Americans coveted the immense, scarcely broken forest that in Ontario and Quebec stretched toward Hudson Bay and Baffin Land. To aid our paper-makers the Federal Government removed duties on imported pulp wood and wood pulp. This not only permitted mills bordering the Great Lakes to secure Canadian wood but brought to us quantities of Swedish pulp. Mills in northern Vermont, New Hampshire and Maine drew upon Canadian forests.

But the Canadians were canny enough to see that the Yankees were milking the Canadian cow. Consequently, much discussion raged in Canada over an export duty on pulp wood, or an embargo upon its export and similar restrictions on wood pulp. Thereupon, American capital crossed the international boundary, acquired Canadian nationality and began to exploit Canadian resources, shipping the paper into the United States, for we use from 85% to 90% of all the paper Canada exports.

This movement of American enterprise to Canada began to be noticeable in 1913. In the next 15 years it accelerated so rapidly that Canadian production, at first negligible, tripled in ten years and actually surpassed our own in 1926, when Canada produced 188 million tons of newsprint to our 152 million tons. Since 1913 there has been almost no increase in the number and capacity of American newsprint mills; on the contrary, since 1920 there has been a recession. One would suppose that the sudden rise of the Canadian paper industry would create a condition of

over-capacity, but throughout most of the period since 1913 the 32,000 American newspapers have increased their circulation particularly of Sunday editions, and the advertising space has grown at an unprecedented rate. Without the Canadian supply, our users of newsprint would have suffered. But by 1926-1927 the Canadian capacity leaping ahead each month began to outpace our consumption. This caused the beginning of distress in American mills making newsprint.

Unless the American consumption overtakes the international production, the American mills are sure to lose ground. For Canadian mills can operate for less cost than ours. The cost of raw materials is 60% of the cost of production, and the low price of Canadian wood due to the immense supply is less than ours. The advantage to the Canadian mills is about 10% in total costs. The result has been the closing of the highest cost American mills in places where the forest has been denuded. Some of these, it may be remarked, though they make no more paper, are profitable to their owners as producers of hydroelectric current for sale to public utilities. We are not likely to regain our paper capacity by imposition of tariff duties upon Canadian paper, for our capacity is not equal to our domestic demand, and our capacity probably will be less rather than greater. That the situation is serious for America may be realized when it is known that over 90% of all paper made in the United States is wholly or in part of wood stock.

Combination: The International Paper Company.—When paper manufacture became large-scale and capitalistic the way was prepared for combination. The first large aggregation was the International Paper Company, organized in 1898 to take over 16 mills: 5 in Maine, 4 in New York, 4 in Massachusetts, 2 in New Hampshire, and 1 in Vermont. At that time, the company was capitalized at 40 millions. Its growth may be measured by the fact that its authorized capitalization in 1927 was 100 millions. It owned or controlled in 1927 no less than 63 companies and was one of the leading owners of timberland and water power in the country. Its timber acreage is greater than the combined area of Massachusetts, Rhode Island, Connecticut and Long Island. As a

paper-maker the International is the greatest in the world, three-fourths of its output being newsprint. With most of its operations in New England and New York, the International visioned the decline of resources there and so has been expanding in Canada and Louisiana. In 1927 it took the first steps for operating in Alaska and Labrador. The Canadian properties are controlled through the Canadian International Paper, Ltd., which in turn controls the Canadian International Paper Company. The Louisiana development is more recent, the business there being devoted to kraft paper. The Southern International Paper Company was created in 1926 to take over the former operating company, the Bastrop Pulp and Paper Company, and to provide for further expansion and mergers in Louisiana. In New England and New York some of the former newsprint mills have been changed to paper of other higher grades; when this was impossible the mills have been closed except for the production and sale of hydro-electricity. In Canada the subsidiary companies control all the electric transmission lines between Ottawa and Montreal.

Combination: The American Writing Paper Company.—An ambitious attempt to combine the mills making fine writing paper was made in 1899, when the American Writing Paper Company was organized. In this company originally 26 concerns were brought together; of the total, 16 were in Holyoke and 4 in the Berkshires, 3 in Connecticut, 2 in Ohio, and one in Wisconsin. The holdings outside of Massachusetts were both added to and subtracted from at different times. After several years of financial difficulties a receivership was asked in 1923, and two suits in foreclosure were brought in 1924-1925. A reorganization was planned in 1926 and put into effect in the next year. The only mills that were retained under the organization were the 16 in Holyoke.

Combination: Book Paper Section.—In the book paper branch of the paper industry the largest combination is the West Virginia Pulp and Paper Company. This corporation operates 15 mills in West Virginia, Virginia, Pennsylvania and New York. The company not only is an example of combination but also of

integration, for it has had the closest connections with Collier's Weekly. Of the other large book paper producers, mention should be made of S. D. Warren and Company, Crocker-Burbank, the Oxford Paper Company, Kimberly-Clark Company, the Bryant Paper Company, and the New York and Pennsylvania Company.

Of those mentioned, Crocker-Burbank is also an illustration of integration, for its entire output is taken by the Curtis Publishing Company of Philadelphia. The New York Times is one of two owners of a very large Canadian development in northern Ontario which includes besides paper mills and power the building of a modern city. This was dedicated with elaborated ceremonies in September, 1927.

Serious Outlook.—Ever since the paper industry started in the United States it has had a gloomy outlook for the future, chiefly because of the scarcity of raw materials. For a brief period after wood pulp first was used, the pall lifted but since 1920 the future again has darkened. Paper is more generally utterly consumed than most products. Most articles after their first use are capable of some sort of remanufacture, but a third of all paper is destroyed beyond redemption, another third is withdrawn in permanent records and books, and only the remaining third is available for conversion, and not all of it receives this treatment. Hence, paper-makers must have ample supplies of new raw material. At present, wood fills that need but the only places in the world with surplus wood for paper manufacture are the United States, Canada, Scandinavia, Finland and Germany. Since all the advanced nations consume more paper each year—our own consumption was 25 pounds per capita in 1910, 42 pounds per capita in 1920, and 52 pounds in 1925—the limited wood resources of the world will not suffice for any great period. Paper-makers, therefore, once more must search for a more abundant new raw material. In the United States this inquiry has begun; if it is not soon successful many of our paper mills must close their doors.

CHAPTER XXI

CEMENT, BRICK AND POTTERY

Sand, Clay and Stone Industries.—Among the major groups of manufacturing industries, one whose divisions have slight resemblance is that in which the principal raw material is sand, clay or stone. Taken together the value of the products of this group is sufficient to rank *ninth* among American manufactures; but the only individual industries whose products in value are comparable to the other industries discussed in this book are cement, pottery and glass.

Cement

When or where in man's evolution from the cave to the palace, skyscraper or cathedral, it was discovered that buildings could be constructed by blocks held together with a binder, is unknown. Equally obscure is knowledge of the materials used for binders. But it seems likely that sandy clays containing alumina, silica and lime, separately and together, were at an early period hit upon accidentally, for these materials are widely distributed over the earth. Their use in construction was passed from fathers to sons for untold generations. In improving these binders probably observation of the beneficence of the heat of the sun suggested greater improvement by moderate application of the heat of fires. The heritage of the ages, these binders were in universal use among peoples whose civilization rose above savagery.

Exceptional binders were those employed by the Egyptians and the Romans. The pyramids were built with a gypsum binder made by heating crude gypsum rock. That the pyramids have stood for so many centuries as monuments to man's achievements is due rather to the climate of northern Africa than to the excellence of the gypsum mortar. The Roman Coliseum, aqueducts, highways and other masonry construction were built with puzzuolana. This

was a mixture of volcanic ash and powdered lime. The ash was a silicate of alumina cooked in nature's kiln, Mount Vesuvius. The name of the cement was derived from Puzzuoli, the Italian city near the volcano where the properties of the cement first were discovered. That the quality of puzzuolana was high is attested by the permanence of the buildings and stucco into which it entered. Unfortunately, the Roman art was engulfed in the deluge of ignorance which inundated Europe after the Goths crashed the Forum. Many centuries later the British manufactured a material they called "Roman cement." Nodules dredged in certain localities and containing lime and silica when burned and ground produced a useful cement. Despite its name, it was not the ancient puzzuolana. Likewise, in America, in 1896, a cement called "puzzolan" was produced by an intimate mechanical mixture of slaked lime and granulated blast furnace slag. Although of different origin, this cement resembled closely the Roman puzzuolana. The production of puzzolan reached its peak in 1907, after which date it declined so rapidly that by 1916 no separate statistical record of its manufacture was kept.

Lime.—For centuries the customary mortar binder was lime. Limestone was piled in alternate layers with a fuel and burned in a kiln. Mixed with sand and water at the job this binder was satisfactory for most masonry work. Indeed, to this day almost 50 million dollars worth of lime is manufactured in the United States.

However, the ordinary lime mortar was unsatisfactory where the masonry came in contact with water, for the latter dissolved the lime in the mortar and caused the masonry to crumble. In practice in central and western Europe it was found that particular deposits of limestone when treated in special ways produced a lime that when introduced into mortar made it more resistant to water than the usual lime mortar.

The beginning of the modern cement industry may be attributed to the researches of a British engineer named John Smeaton who, in 1756, was engaged to rebuild the Eddystone Lighthouse. This beacon exposed to the lashing of salt water, had given constant trouble because the best known hydraulic lime

mortars had failed. Smeaton, therefore, made a series of experiments with hydraulic mortars. His most important discovery was the fact that water-resistant mortars did not depend on the purity of the limestone, its color or texture but upon the percentage of clay entering into its chemical composition.

Natural Cement.—Smeaton published the result of his experiments in 1791. Engineers, contractors and others tested Smeaton's conclusion and searched Great Britain for suitable materials. Both in England and in France individuals were granted patents for the manufacture of cements composed of lime silica and alumina found mixed in nature. Smeaton's practice was improved by subjecting these new cements to a burning process longer and at higher temperatures than had been the custom in respect to lime. Since the raw materials for the new cements were found in rocks in almost the correct proportions the product was called "natural cement." For a quarter of a century "natural cement" had no superior in the field of mortars.

Natural cement had been in common use in Europe for nearly two decades before it appeared in the United States. Masonry was far less common in America than in Europe because we were endowed with cheap lumber. Hence, for many purposes for which stone or brick were used in Europe, we employed wood. Our buildings, pavements, sewer boxes, plank and corduroy roads, and bridges were constructed of wood instead of the more durable but more expensive masonry. Wooden fences also were substituted in places where the Europeans would build masonry walls. Wherever masonry was in use in America the old-fashioned lime mortars were adequate.

Stimulus to the Industry from Building the Erie Canal.—But when in 1817 the Erie Canal was started it involved water-tight masonry for locks, walls and troughs (bridges) in which the canal was carried over streams and small valleys. Nevertheless, the engineers in charge of construction of the Erie Canal specified and used hydraulic lime until two of them by accident came upon deposits of rock near the line of the canal suitable for manufacturing natural cement. There are two conflicting stories con-

cerning this episode. The one generally accepted is that Benjamin Wright and Canvas White, in investigating the cause for the failure of certain lime to slake taken from a limestone quarry near Fayetteville, Onondaga County, New York, found that the quarrymen had stumbled upon a rock resource similar to that from which the British were manufacturing natural cement. The other account states that White made his discovery near Chittenango, Madison County, New York. At any rate, the side walls and locks of the central section of this historic waterway were built with natural cement, for the use of which White was handsomely rewarded by the state.

The great practical water resistant virtues of natural cement demonstrated in America in the building of Clinton's "Big Ditch" led to the use of natural cement in all the other waterway projects that followed the success attained by New York's experiment. There came to be, therefore, a close association between the manufacture of natural cement and the extension of canals. All of the important canals gave rise to nearby cement manufacturing plants. The Delaware and Hudson Canal was supplied from the cement mills at Rosendale, New York; the Louisville and Portland Canal, by those at Louisville, Kentucky; the Muncy and Lock Haven, by the works at Williamsport, Pennsylvania; the Chesapeake and Ohio, by Round Top, Maryland; the Illinois and Michigan, by Utica, Illinois; the Easton and Mauch Chunk, by Siegfried's Bridge, Pennsylvania; the Lehigh by Coplay, Pennsylvania; and the Richmond and Allegheny, by Balcony Falls, Virginia.

The canals not only caused the opening of these cement mills and provided them with their first market but after the waterways were finished they were the means of transportation for the heavy, bulky, low-valued product to consumers of cement in villages, towns and cities along the canal route and beyond by other waterway connections. In many cases, too, the canals furnished water power to operate the cement mills. Since the cement was shipped by water it was packed in water-tight barrels. Later, natural cement and other varieties were shipped in other packages, as well as in bulk, but the barrel has continued to be the standard for computations of output and quotations of prices.

The production of natural cement which began with an annual output of about 30,000 barrels in 1818, reached 100,000 in the thirties, a million in the fifties, and 2 million in the seventies. Its output advanced steadily until it reached the peak in 1899, when almost 10 million barrels were manufactured. From that date, production gradually fell off in competition with other kinds of cement, so that from 1918 onward the output has ranged between a half million to one million barrels. At the time of maximum output natural cement was manufactured by about 70 firms operating approximately 100 plants in 15 states.

Localization of Natural Cement Industry.—The influence of water transportation is apparent in the localization of the national cement industry at its height. By far the most important manufacturing center was near Rosendale, Ulster County, New York. The 15 concerns at that point furnished 41.9% of the natural cement manufactured in 1898. Rosendale cement had an excellent reputation for quality, but the remarkable development of the industry was due to the cheap transportation by way of the Hudson River to the largest national market in New York City and the string of cities along the Hudson and Mohawk valleys.

The second most important natural cement manufacturing region was that close to Louisville, Kentucky. The business began at Louisville in 1829 and continued until 1905. Louisville, where the Ohio was interrupted by falls, was the focal point for the river, canal and landways that branched from the Ohio northward into Indiana and Illinois, and southward through Kentucky and Tennessee. From a single works erected by John Hulme, in 1829, the cement industry near Louisville had grown to 18 plants in 1892, having a yearly output of about 2 million barrels, which was about 25% of the national production. After 1892 the Louisville district began to decline, but during its heyday it furnished cement for most of the bridges, water-works, tunnels, locks, dams, street foundations, pavements, sidewalks and sewers constructed within 150 miles of the river city. Some Louisville cement was used as far north as Canada, as far west as the Rockies, and as far south as Florida.

When the Lehigh Coal and Navigation Company began to

canalize the Lehigh River from Mauch Chunk to Easton, General Siegfried built a small natural cement plant at a place near the river and canal that bears his name. Cement from this mill was used in building the waterway. The Siegfried enterprise was not so significant in developing the natural cement industry of the Lehigh Valley as the Coplay Cement Company, owned by David O. Saylor, Esias Rehrig and Adam Woolever. The plant was located at Coplay, close to the Lehigh Valley Railroad. Four other natural cement plants were operated in the Lehigh Valley and the six together had a combined output of 750,000 barrels in 1898. Although these valley works had an excellent outlet both to Philadelphia and New York, and their product was well known and received in these markets, the valley was nowhere near so famous for natural cement as Rosendale and Louisville. In the Lehigh Valley the early production of portland cement and the growth of that product quite overshadowed the natural cement; yet the Lehigh Valley was the third most important region in the output of natural cement.

Portland Cement.—Joseph Aspdin, a British bricklayer with a flair for experimentation, discovered that when the materials of which natural cement was composed were subjected to extraordinary high temperature the materials fused into a clinker. When the clinker was ground, Aspdin found he had a cement far superior to "natural cement." Aspdin was a pragmatist; he knew nothing of the chemistry of his discovery nor why the cement acquired new virtues from the special treatment he gave it, but he was well aware of the fact that the new cement was superior to the old, so he patented his process in 1824. The name given to the product is an illustration of Gilbert's famous line, "Things are seldom what they seem." For the new binder was called "Portland cement" not because it originated there, but for the reason that when set, this cement bore a fancied resemblance to a popular building stone that hailed from the Isle of Portland. Westminster Palace for instance, was built of Portland stone.

The man who explained the why and wherefore of Aspdin's results was a Britisher named Isaac Johnson. As a consequence of his work it was feasible to make portland cement with a reliable

uniformity. After 1850 the possibility of manufacturing consistently proportioned portland cement caused the superior quality of the product to gain for it a ready market, first in England and then in France and Germany. The number of plants and their output grew so rapidly that they not only furnished the engineering and construction professions of their own nations with the material but had enough to seek export markets in North and South America.

Portland Cement Imported to the United States.—Importations of foreign portland cement began in the late sixties but the amounts were insignificant because our builders knew extremely little about the product. During the seventies, however, trade journals featured portland cement in leading articles, while European engineers engaged for American construction, as well as American engineers visiting Europe, spread the fame and virtues of portland cement among our people. Recovery from the Civil War and the panic in the early seventies was evidenced by a building boom in the United States. Larger, higher buildings were erected in the cities, while both the greater and lesser communities began to lay miles of sidewalk. Improved city water and sewer systems were the order of the day. In Washington, Philadelphia, and New York asphalt pavement on a concrete base began to appear. For all these constructions portland cement was in demand. Hence our imports rose to 92,000 barrels in 1878 and were 187,000 barrels in 1880. By 1885 we were importing a half million barrels and five years later the figure had reached almost 2 million. For a decade the imports held at this amount but after 1900 began to shrink. From 1907 onward the imports showed a decided drop and were only 85,000 barrels in 1913. After the World War importations increased so that the million barrel mark was passed in 1923 and 4 million reached in 1926.

Through the seventies and eighties the freight charge on foreign portland cement was low because it was carried as ballast by vessels that transported American grain or cotton to Europe. Indeed, there were authentic cases when grain rates were very high that the cement was freighted at no charge at all and the consignees were paid a fee per barrel for speedy unloading. Thus, at

Atlantic, Gulf and Pacific ports where grain or cotton were shipped foreign portland cement entered cheaply. Sales organizations for this alien cement were deeply entrenched in the American seaboard markets. Where water carriage inland was available, the imported portland cement penetrated the interior domestic markets, but if railroads were the only means of transportation, the journey from the coast was limited because the charge for the heavy, cheap material soon equalled its value. Domestic natural cement filled the markets beyond the influence of the water carriers. As a result, when the American portland cement industry began it had to meet the competition of well-established foreign brands of portland cement and, in addition, the rival claims of domestic producers of natural cement.

Pioneer Portland Cement Makers in America.—David O. Saylor who, with his partners Rehrig and Woolever, was manufacturing a popular brand of natural cement at Coplay, Pennsylvania, turned his attention, in the late sixties, to experiments in the production of portland cement from the cement rock of the Lehigh Valley. With the help of a young chemist, John W. Eckert, Saylor succeeded in manufacturing an excellent portland cement, which he patented in 1871. This cement was awarded a prize at the Philadelphia Centennial in 1876 and meanwhile had enjoyed a wide sale over the United States in important engineering works. Saylor, however, did not abandon his natural cement output; indeed, he obtained much natural cement as a by-product of the process he used for manufacturing portland cement.

It was in 1871 also that Thomas Millen, a manufacturer of cement sewer pipe and other cement commodities at South Bend, Indiana, abandoned the use of imported portland cement which cost him \$9.12 per barrel, and began to produce portland cement from marl found in the lakes at Notre Dame and blue clay taken from the river bed. The suggestion for this radical step came from an English workman in Millen's employ, who had formerly been employed in England by the company that made the portland cement which Millen had been using. Millen experimented for six months before he erected his first portland cement kiln, and his preliminary work was done so carefully that his commercial

production was a success from the start. Of course, the location of his works was a decided advantage over imported portland cement and the natural cement of the Louisville district.

The third pioneer was John K. Shinn of Wampum, Pennsylvania. Shinn had been secretary and treasurer of a company producing natural cement at Wampum. He had experimented for years in the making of portland cement, and with the aid of William Pucall, an experienced cement craftsman, began, in 1874, to manufacture portland cement for sale.

A portland cement company also was started at San Antonio, Texas in 1850, another a little later at Egypt, Pennsylvania by Lesley and Trinkle, formerly cement sales agents at Philadelphia, still another by a Mr. Middleton, at Oregon City, Oregon, in 1884, and the Eagle Portland Cement Company of Kalamazoo, Michigan was established in 1885. Thus, many men in several separated localities in the seventies and early eighties were laying the experimental foundations upon which in later decades was raised the greatest portland cement industry in the world. But before this pinnacle was reached our manufacturers were forced to unlearn foreign precepts in the production of portland cement, and to adopt processes and methods that fitted American economic conditions.

European versus American Methods.—The European raw materials for portland cement were finely divided lime-bearing clay muds. The proportioning of lime, alumina and silica was accomplished in vats with the materials in a wet pasty state. After mixing, the mass was spread over great fields where it was dried by sun and wind. When ready, the thick brick-like stuff was broken into lumps which were fed by hand into a kiln. This furnace was an enlarged lime-burner shaped like a lamp chimney, a row of them being placed side by side. The charge was alternate layers of coke and the prepared mixture of raw materials. After firing for a week the contents were drawn manually and the cement separated and graded by hand.

This process was economical with fuel but prodigal of hand labor. Since in Europe fuel was expensive and labor cheap, the method fitted economically into European conditions.

Americans who started the domestic portland cement industry naturally duplicated foreign processes in making what had been an alien product. But the methods were most uneconomical in America, for the reason that fuel was cheap and labor expensive. Our domestic producers, therefore, were submerged in disadvantages. The Europeans had a long established industry at home, a well-equipped marketing system in the United States where their brands were in high favor, and ocean rates so low that British manufacturers could place their cement in New York cheaper than domestic producers in Pennsylvania. How hard pressed our makers were may be realized from their practice of shipping cement in bulk to city wholesalers who packed it in second-hand barrels which had contained either foreign portland cement or domestic natural cement. The saving in barrels was the extent of the American's advantage in price, and the chief selling argument was this slight margin. Obviously, Americans had to change manufacturing methods so as to reduce costs of production.

American Methods: The Kiln.—Our first effort to fit the manufacture of portland cement to American economics was directed at saving labor in the handling of raw material. We abandoned the field-drying of the wet paste and substituted drying rooms heated by waste gases from the top of the kiln. Another temporarily successful method was the admixture of gas-house pitch with the raw material, which, shaped like small eggs, was fed wet into the kiln. This saved some of the drying and the pitch acted as a fuel. But when the city gas works turned to water-gas, pitch was no longer to be had for the price of removal from the gas plants.

The first real advance was made in 1886 at Rondout, New York, when Jose F. de Navarro and his two sons erected a rotary kiln. This was a cylinder 24 feet long with a diameter of 12 feet, fed and discharged from a central opening. Indeed, the idea was borrowed from the common peanut roaster, the kiln being an enlargement of this familiar machine. The Navarros used crude oil as a fuel for at that time crude oil from Lima, Ohio, could be purchased at Rondout for 2 cents a gallon. This first

American rotary kiln was operated two years by the Union Cement Company of Rondout, but results were distinctly unsatisfactory.

Navarro by chance learned of a rotary kiln invented by Frederick Ransome in England and operated by the Gibbs Portland Cement Company at Grays on the Thames. In 1880 Navarro took ship to England and after several months of investigation and bargaining returned to America with the rights to use the Ransome patents here.

A Ransome kiln was erected at the Keystone Portland Cement Company of Coplay, Pennsylvania, in 1889, and after a preliminary difficulty began producing portland cement in 1890 that compared favorably with the best European products. The Keystone Portland Cement Company controlled by the Navarro family was renamed the Atlas Cement Company.

The first American Ransome kiln was 25 feet long, 5 feet in diameter, fed at one end and discharged at the other, the fuel being crude oil. Later progress with the rotary kiln has consisted in increasing its capacity and varying its fuel. The length of kilns was increased first to 40 feet, then to 60 feet, and later to 100 feet. Not satisfied even with that length, kilns 120 feet on up to 260 feet were built. Some have been erected that were 342 feet long. At the same time, the diameter was enlarged from 5 to 6 feet and up to 12 feet. The kiln is the largest piece of revolving machinery used in any industry. So heavy are the larger kilns that the foundations are as strong as for a ten-story reinforced concrete building. Fuels in rotary kilns have been crude oil, natural gas, and powdered coal, the choice determined by availability and relative price.

The advantages of the rotary kiln were that the mixed raw materials whether wet or dry were fed into it without handling. Moreover, manufacture was continuous, and the product as great per hour as the old intermittent upright kilns had turned out per fortnight. This machine, therefore, fitted America, for it conserved labor, was prodigal with fuel—which was cheap here—and yielded mass output.

Yet in the nineties, the rotary kiln was met by severe opposition. Conservative manufacturers of portland cement clung to

the older kilns, although compelled to modify them so as to allow continuous production with some saving of labor. Equally unprogressive buyers were prejudiced against the new method and claimed that the machine's product was inferior to that made at home and abroad in the older kilns. These opponents to change were slowly won over to the rotary kiln, although they were not so much induced as compelled to recognize its merits.

Preparatory Machinery.—The development of the rotary kiln was accompanied by corresponding mechanical large-scale preparation of raw materials. In cement rock quarries all hand work was eliminated. Great masses were blown down with one charge, and the pieces scooped with steam shovels. Plants using soft materials likewise turned to machine dredges or shovels. The materials were moved to crushers and mixers by mechanical conveyors.

The crushers at first presented a difficult problem. The original crushers were so small that pieces from the quarry were broken apart by hand sledges, but improved crushers of great capacity were installed so that rocks larger than the first crushers were fed into the mammoth jaws of the new machine.

After crushing, the materials must be ground so fine that when felt in the fingers no grit at all is apparent. Here, again, progress was slow because the only known method of pulverizing was by grindstones. The expense for dressing these stones and keeping them in good condition was appalling, for the stones wore out more rapidly than they could be repaired. At length ideas from the fertilizer industry where phosphate rock was pulverized were borrowed, which got rid of grindstones. Several types of grinding machines were introduced. One was a series of rotating steel rolls. Another was a gigantic rotating steel tube, within which tons of steel balls or of hard pebbles fell continuously upon the raw material as the tube revolved. Still another was a revolving tube which was fitted with a gigantic hammer whose handle was attached to a universal joint so that the hammer swung upon the raw material as the great tube turned. These titanic mechanisms shivered pieces of mountains to floating dust.

Machines of the same types were used to reduce the clinker

after the cement was burned. The pieces of clinker coming from the kiln ranged in size from that of cherries to that of melons and were harder than diamonds. Yet the Gargantuan pulverizers converted the clinker to a powder so fine that 85% of it passed through a copper sieve with 40,000 openings to the square inch. That is, the sieve had a mesh more finely woven than silk and one that would hold water. It would take 14 million pieces of pulverized portland cement to cover 1 square inch of surface.

Fuel.—The pioneer manufacturers of portland cement fired their vertical kilns with anthracite coal, but even then anthracite was starting its climb toward the luxury class. To be sure, the kilns utilized the smallest, cheapest sizes of anthracite; nevertheless, anthracite was a relatively costly fuel. When the rotary kiln was erected at Rondout, as it was realized that the new machine would be greedy for fuel, anthracite was abandoned in favor of crude oil. This fuel not only was cheaper but was adapted to mechanical firing. For six years crude oil held the field but, in 1895, it was found that cheap bituminous coal could be powdered at the cement plants in the same kinds of machines used for the raw materials. The powdered coal then could be blown into the kiln just as easily as oil. From that time pulverized soft coal has been the usual fuel, except near oil and natural gas resources; even in the exceptional cases where crude oil or natural gas have been employed they often have been mixed with powdered coal. Since the cement works could use bituminous slack they could buy it for less than one dollar a ton.

The cost of fuel, burning constantly in a torch 30 feet long, is a vital factor in the manufacture of cement because the consumption is gigantic. For every ton of cement a half ton of coal is burned, so that every day 200 tons or more are consumed. The cement industry is the largest consumer of powdered coal and the fourth greatest industrial user of coal in all forms. The temperature in a rotary kiln is one of the highest in all manufacturing processes; it exceeds the temperature for melting steel, and is greater than that in the crater of Vesuvius when that mountain spumes.

While the major expenditure for fuel is in connection with

the kilns, a large amount is necessary for power. Everything about a cement plant is on an exaggerated scale; all the machinery is gigantic and weighted down with materials of enormous tonnage. Hence, to move this machinery excessive power is required. Moreover, all materials are moved from one machine to another by mechanical conveyers; no hand touches cement until the stevedore heaves the bags into freight cars. Therefore, the power facilities of a moderate sized cement plant would serve all the needs of a city of 150,000 people.

To be sure, some of the power is a by-product. The hot gases escaping from the kilns are conducted to boilers where steam is raised for engines. The first use of this waste heat was made in 1898 at the Nazareth Cement Company of Nazareth, Pennsylvania. Cement plants can rely upon this source of power from 50% to 100% of their total power requirements. The introduction of electrical transmission and motor drives in cement plants contributed marked economies in the location of machinery, reduction of repairs and renewals, as well as in power itself.

With such demands for combustion in the kiln or for fires in the power houses, cement manufacturers must be strict in their watchfulness over fuel. An American cement plant is impossible in regions where fuel is at famine rates.

Price of Cement.—In 1880, when portland cement was put upon the American market, it was offered at \$3 per barrel. This was not an excessive price, for the crude methods of manufacture of that time were so badly adjusted to American economic conditions that the expenses of production were extraordinary. As a matter of fact, a \$3 price proved too low, for some of the first companies were commercial failures.

One by one as our manufacturers perfected grinding machinery and rotary kilns, and solved the fuel problem, the market price of cement steadily dropped with only brief spasms of upturn until 1909, when the price was 81 cents per barrel. The price fluctuated between 80 and 90 cents until 1913, when it advanced to \$1, but a price war dragged it back in the two following years. Thereafter the price rose as high as \$2 in 1920 and since that date down to 1927 fluctuated between \$1.75 and \$2 per barrel.

Increased Production and Consumption.—The drop in price of portland cement put it on a par with its competitors, and its superior qualities gave it preference over all others. By 1900 the quantity of portland cement produced was greater than natural cement, when each turned out more than 8 million barrels. From that date natural cement output declined, whereas portland cement rose to 164 million barrels in 1926. The largest amount of portland cement ever imported until 1925 was in 1895 when 2.9 million barrels entered our ports. In 1925 the imports were 3.6 million barrels and the next year mounted to 4.2 million barrels. The record of domestic production and consumption of portland cement since 1880 has been one of astounding increase. By 1890 there were 16 plants, with a total output of 335,000 barrels per year. At the end of the next decade the number of plants was 50 and the output 8 million barrels. This pace was maintained so that with the passage of two more decades the 118 plants in the country were producing and selling 137 million barrels of cement. The daily output of 1923, 375,000 barrels, was greater than the production for a year in 1890. The capacity of American mills in 1927 was 200 million barrels, the greatest in the world; indeed our capacity was greater than the rest of the world combined.

As everyone knows portland cement was the favored binder for concrete, so that the progress in the use of concrete was reflected in a demand for cement. The greatest demand for concrete—and hence, cement—has been for public and commercial buildings. The first factory built of concrete was that of the Pacific Borax Company of Bayonne, New Jersey, erected in 1877. The second largest demand for the associated materials has been for pavings and highways, and this market bids fair to surpass the first. Of course, it was the automobile that gave impetus to the movement for good roads. Where traffic is heavy and particularly where automobile trucks are common, the concrete highway has proved the most permanent, most satisfactory roadway.

The farm has been the third best customer for cement. There are dozens of uses for it around barns and farm dwellings. The

farmers have been well instructed in the virtues of the material and in the methods for using it. Their response has been nationwide, and enormous in the aggregate even though each man buys but a few bags at a time.

Besides these consumers, cement has been in demand for dwellings, sidewalks, private driveways, railways, pipe lines, bridges, dams, tanks, and monuments and sculptures.

At the beginning of the century we used about a quarter of a barrel of cement per capita, but the many uses mentioned so increased the consumption that the per capita figure, in 1923, was five times as great. Put in another way, our daily consumption in 1923 was about 450,000 barrels, which caused the cement producers to load five carloads every working minute.

Standardization.—Portland cement despite its rapid climb in public favor, could not approach its ultimate consumers' demand so long as each manufacturer put on the market a product slightly different from all the others, and itself not uniform. Each maker's cement varied from time to time and few makers had identical products. In 1898 Robert W. Lesley, a cement salesman and later a manufacturer, collected almost 300 different specifications for portland cement.

Architects in specifying portland cement were needlessly worried over the varying properties of the material. Contractors, likewise, could not figure definitely on bids nor finish jobs already started without allowance for wide margins of error in the qualities of the cement. Workmen, too, were baffled in mixing cement whose content varied, for they could not be sure of results.

To remove the objections the American Society of Civil Engineers, in 1885 and again in 1903, laid down standard formulae for testing portland cement. In 1904 a greater forward step was taken when the American Society for Testing Materials announced a standard for portland cement. This standard was revised in 1908 and again in the following year. Although these efforts were not without influence, they were not fully efficacious, for many manufacturers felt they had a more secure hold on their market—a "talking point"—if they adhered to their own formula. They thought they could convince buyers of the superi-

ority of their product over all the slightly different products of competitors.

However, by 1917, the confusion due to differences in standards as laid down by engineers and by government bodies was seen by most manufacturers to dampen sales. So committees were chosen by various engineering societies, by cement manufacturers, by consumers of cement, by governmental bodies, and by testing laboratories to consult with each other in order to select a standard specification for portland cement. After lengthy deliberation extending from 1917 to 1922, the committee decided upon a standard. On March 31, 1922, the specification adopted by this committee became the first American Standard Specification for portland cement. The United States Government Specification announced at the same time included identical requirements.

Most of the manufacturers of portland cement conformed to the standard specification, but not until later in 1922, when acceptance of the standard was made a condition of membership in the Portland Cement Association, could it be said that the standard was practically universal.

Cement manufacture from that date has been unusual, although not unique, in having a product identical, no matter who makes it. This removes all individuality from the manufacturer's article and puts the sales effort on price. In turn, the all importance of price rebounds upon the managers of the works to cut to the bottom the costs of production. The final result is to foster agreements on price among manufacturers and to conduce toward zoning the country in accord with freight rates.

Location of Plants.—The raw materials for manufacturing portland cement are lime, silica and alumina. In nature these are found grouped together in various proportions in cement rock, marl, shale, clay and blast furnace slag. As the constituent that controls the mixture is lime, this material is added in correct amounts to those mentioned.

All of the raw materials are abundant in the United States and it is an unusual area that does not contain them. Yet materials free from objectionable compounds are relatively rare. On

the basis of raw materials, however, a cement plant might be put almost anywhere in the United States.

The factors that actually control the location of plants are adequate supplies of cheap fuel, and favorable freight rates to large consuming markets. The first is understandable from what has been said previously. The second is appreciated when one realizes that cement is so bulky, heavy and cheap that the cost of carriage for 100 miles equals one-third the mill price. Hence, the 118 producing plants, owned by 90 companies in 1926, were distributed over 27 states, with clusters close to the largest cities. The densely populated areas close to the Atlantic were served by 26 plants in Pennsylvania and New Jersey and 11 in New York. In a ring around Chicago and Detroit there were 16 plants in Michigan, 4 in Illinois and 2 in northern Indiana. Pittsburgh was the focus for 7 plants, St. Louis for 9, Denver for 2, and Salt Lake City for 3. Upon the Pacific Coast, Seattle had 2 near-by plants, Portland 1, San Francisco 6, and Los Angeles 5. That is, almost three-fourths of the plants were close to the cities named. Another way of showing the influence of market on plant location is the fact that the largest producers in 1926 were found in Pennsylvania, Indiana, California, Michigan, Missouri, New York and Illinois. The states ranked in accord with the order of total consumption of cement in 1926 were New York, Illinois, Pennsylvania, California, Michigan, Ohio and New Jersey. In per capita consumption, the ranking states in 1926 were Florida, California, Michigan, Illinois, New Jersey, New York and the District of Columbia.

Lehigh Valley.—The most marked localization of manufacture occurs in the Lehigh Valley, partly in Pennsylvania and partly in New Jersey, where there were 20 plants in 1926, or more than twice as many as were found in any other locality. The primary cause for the supremacy of this district, aside from the advantage coming from the original starting of the industry there, lies in its nearness to the large construction markets in New York, Philadelphia, Baltimore and Washington. The valley has excellent railroad connections established for the hauling of coal to these markets, but fully utilized by the cement manufacturers. Further-

more, the district is in the region of cheap fuel, for the price of bituminous coal is kept down by the potential competition of the adjacent anthracite mines. It happens, too, that this valley contains a large deposit of high-grade cement rock. This rock has the advantage not only of containing the constituents of cement already mixed but also of being easy to quarry and relatively free from water. Limestone is quarried in the same pits with the cement rock. Since the rock is dry and the materials prepared by nature, the cost for fuel and grinding is reduced. The costs of manufacture in the Lehigh Valley are the lowest in the United States and the quoted mill prices there generally have been below the average for the United States. The rapid increase in the use of cement in all other parts of the country, however, has led to the installation of so many plants outside of the Lehigh Valley that the relative importance of the district in the industry is constantly declining, resembling in this respect the position of the city of Pittsburgh in the steel industry. The highest relative position of the Lehigh district was attained in 1899, when this section manufactured 72.7% of all the portland cement made in the United States. From that pinnacle the district declined until, in 1926, it was responsible for less than 25% of the national total. It must not be overlooked, however, that the actual volume of the district increased each year from its inception until 1907. For 14 years thereafter a steady production of about 25 million barrels was maintained until 1922, when production again began to mount.

Analogy to Steel.—There are many similarities between the making of cement and of steel. Both are cheap and bulky, both must tap a large market near-by, and both require car service throughout twelve months of the year. On this latter account, cement plants in the South and West are handicapped because the car tonnage is so much in demand for the movement of crops during a portion of the year. With both cement and steel the freight charge has entered largely into the final cost to the consumer. Other similarities between cement and steel are the dependence upon fuel, the heavy investment in plant in proportion to the value of output and the close sympathy between

the sale of products and general business conditions. After iron and steel, cement affords one of the best barometers of business conditions; in both cases this is due to the wide use of the materials for structural purposes. Neither steel nor cement can be manufactured upon a small scale, for the initial investment in plant is large; yet in each case the margin of profit per unit is small so that volume of output is essential. This gives capital a strategic advantage and points toward large-scale production in an industry whose smallest units are large. In a half-century the tonnage of cement has swept from less than 1% of that for steel to about half as much. The close analogy in so many respects between cement and steel leads to questioning whether cement manufacture will follow the lead of steel by coming under the control of a limited group.

Movement Toward Consolidation.—It is sometimes said that this cannot happen because the raw materials are so universally available that potential competition will always offset monopoly. But this easy assumption overlooks the large initial investment required, the necessity for a large market, and the importance of cheap fuel. Furthermore, as the business is peculiarly mechanical, patents on rotary kilns or grinding apparatus could easily supply the key to monopoly. As a matter of fact, this movement gained considerable headway.

The first step toward consolidation was taken in 1906 when the North American Portland Cement Company was organized with a capital of 10 million dollars to act as a patent-holding company. The patents held by this company were those owned by the Atlas Portland Cement Company, which possessed the American rights to the Ransome rotary kiln as well as the Hurry and Seaman patents which covered the use of powdered coal in rotary kilns. The companies which were licensed by the North American Portland Cement Company were the Atlas, Alpha, American, Lehigh, Lawrence, Vulcanite, Dexter, Edison, Nazareth, Pennsylvania, Penn-Allen and the Catskill. Litigation over the use of the patents caused the North American Company to organize, on January 9, 1908, the above into the Association of Licensed Cement Manufacturers. This association represented

70% of the portland cement industry in the United States. However, the patent litigation was decided adversely to the North American Company and the Association, so the whole organization lapsed and eventually was dissolved.

At the same time (1908), in order to command facilities to dominate a market, various plants were grouped under single managements. These groups followed two policies; one to combine various works in one region, the other to control plants scattered in different market areas. There were 9 recognized groups. Combinations of these sorts have continued in the industry but the groupings have been changed from time to time. Since the World War effort has been concentrated upon obtaining plants near different markets. No group or company ever has obtained dominance of the industry.

In 1926 the largest concern was the Atlas Portland Cement Company. The nine mills belonging to this company were located as follows: 3 at Northampton, Pennsylvania; one at Coplay, Pennsylvania; two at Hannibal, Missouri; one at Leeds, Alabama; one at Hudson, New York; and one at Independence, Kansas. The two last named were operated by subsidiary companies. The combined capacity of the 9 plants was 52,000 barrels per day. The Lehigh Portland Cement Company was the second in size. This company had 16 mills, of which 8 were in Pennsylvania, 2 in Indiana, and one each in Illinois, Iowa, Kansas, Washington, Alabama and Virginia. The daily capacity of this company was 48,000 barrels. The Universal Portland Cement Company, with a daily capacity of 46,000 barrels, is interesting because it is a subsidiary of the United States Steel Corporation and was created to make use of the slag by-product of steel manufacture. The company was organized in 1896 as the Cement Department of the Illinois Steel Company and began selling cement that year. This product, although puzzolan, was sold as portland, which resulted in suits against the steel company. A decision adverse to the company was rendered in 1898, whereupon the company, though using the same raw materials, nevertheless changed its methods so as to produce genuine portland cement. A corporation separate from the Illinois Steel Company was created in 1906. This, the Universal Portland

Cement Company, in 1927, had 5 plants, three of which were close to the Chicago steel mills, one near the Pittsburgh works and one at the Duluth subsidiary of the United States Steel Company.

Besides these three leaders there are two other large-scale producers of portland cement. One of these, the Alpha, has 10 mills in 8 states and a combined daily capacity of 32,000 barrels of cement. The other, the International Cement Corporation of New York, has 5 mills, of which one is in New York and the rest in the south and southwest. Their combined daily capacity is 27,000 barrels.

That the 5 leaders are a long way ahead of the majority of companies is evident when it is known that two-thirds of the cement companies have a daily capacity of 4,000 barrels or less. Yet the combined capacity of the 5 leaders is only about a third of the total national capacity. Under these circumstances, the danger of monopolistic production of cement is remote.

Although monopoly is not an offense in the cement industry charges of price fixing have been made. An organization called the Cement Manufacturer's Protective Association was sued in June, 1921, by the federal government on an indictment of agreements to maintain prices in violation of the Sherman Act. A lower court decided against the defendant, but the case was appealed to the United States Supreme Court. No decision had been rendered when this page was written.

Local Natural Monopoly.—Whether or not the cement manufacturers have unlawful agreements as to prices, there is a natural local monopoly in the industry due to its very nature.

The plants in any geographic area have a zone bounded by freight rates in which these plants have an advantage over all others located outside the area. Each sack of cement contains 1 cubic foot of material—for convenience in measuring at the point of use—and weighs 94 pounds. The average price for this amount of cement has been 25 cents. However, if a consumer were 100 miles from the mill the sack would cost him $32\frac{1}{2}$ cents, and at 200 miles the delivered price would be 40 cents, the extra amount being the freight charge. So long as the mills near-by

deliver cement at 25 cents, the consumer has no incentive to patronize the mill 100 or more miles away. The distant mill cannot justify a higher price on the grounds of quality, for all the mills produce a standard material. All the mills within the area where sacks could be delivered for 25 cents, therefore, have a natural monopoly, the fewer the number of plants the closer approximation to monopoly. Their monopoly is limited, however, by two factors. First, their local price cannot go above the amount measured by the freight charge and, secondly, distant mills, in order to enter the market or to keep their mills going at maximum capacity, may reduce their mill price by the amount of the freight rate. They will do this only when business falls off in their own zone to such an extent as not to take the entire mill output. When business booms each mill tends to confine its sales within its own natural territory, but when construction declines salesmen invade "foreign" areas. But even then there could be hardly any competition between such widely separated plants as those, say in Michigan and near Seattle. It is difficult to see how the mills near Salt Lake City or Butte, Montana, could have any continuously effective competition, except from new plants erected in the same market area. In short, cement manufacture partakes of the nature of brick-making—it must be done reasonably close to market, may have approximate local monopoly but not national monopoly. Combination of dominant plants in each market area always is offset by potential competition from new plants in that area.

If the above is true, how may one explain the rise of imports of portland cement since the World War? The answer lies in relative mill costs. Our mills to manufacture at lowest cost must run at full capacity since our processes are fully mechanical and hence capitalistic. Unfortunately, our productive capacity since the World War has been about 20% above our consumption. Hence, the industry has operated short of full capacity, with the consequence of higher unit costs. This has been reflected in high prices for cement. On the other hand, European mills depend less on machinery and more on labor. The wages of cement workers abroad since the war have ranged from 75 cents to 90 cents a day. Therefore, European cement manufacturers

have enjoyed low costs. The high price in our domestic market enabled this European low cost cement to cross the ocean and invade our seaboard cities, there being no cement tariff to hurdle. The Europeans, too, were faced with a slack home market after the war and so used the American market as a dumping ground for excess supplies of cement. The imports, however, amounted to less than $2\frac{1}{2}\%$ of our domestic production.

Portland Cement Association.—In 1902, in response to a circular letter issued by the general sales agent of the Vulcanite Cement Company but probably inspired by John Loger, the president of that company, a group of men representing 24 eastern companies manufacturing portland cement met to discuss the burning issue of the handling of returnable cement bags. So much enthusiasm was engendered by this meeting and so thoroughly appreciated was the value of common attack on common problems that another meeting was called the same year to perfect a permanent association. Thus was born the "Association of Portland Cement Manufacturers," better known for the first few months of its existence as the "Eastern Portland Cement Manufacturers." The imminence of the St. Louis Exposition (1904) and the desire to present a collective exhibit of portland cement led to the inclusion in membership of the Central Cement Association. In 1903 the quarterly meetings of the A.P.C.M. began a policy of education by including the presentation of scientific papers in the order of business. Committees, too, were appointed to cooperate with similar committees of engineering and other societies for research work and the establishment of standards for cement and concrete. In 1904 the name of the association was made to include the word "American," so became "The Association of American Portland Cement Manufacturers." In 1916 this title was shortened to "Portland Cement Association."

In 1904 the association appointed a paid secretary to coordinate its work. The secretary's office expanded by 1926 to include 561 employes in 32 branch offices in cities scattered over the nation.

To facilitate research and tests the association, in 1916, made a contract with Lewis Institute, Chicago, whereby that institution

provided a Structural Materials Research Laboratory, where research pertaining to cement and concrete was conducted under an advisory committee upon which the Portland Cement Association had representation. The association appropriated funds to support this project. But in 1926 the association organized its own laboratory with a staff of 36 investigators.

The association has performed an unusually valuable service to its members in research and education. Although it has no function in connection with individual manufacture or sales, it has promoted general sales and extended the demand for cement by its publications and news items furnished to periodicals, by providing instructions to users of cement and by making staff assistants available for advice on job problems.

Clay Industries: 1. Brick

Process.—The two main groups of industries based upon clay as a raw material are the manufacture of bricks and the making of pottery objects. Measured by the total value of products, the number of plants, or the number of workmen engaged, the brick industry is about four times as important as the pottery, although the latter is much more spectacular.

Although bricks are composed primarily of clay, special varieties also contain some sand to prevent shrinkage and other materials to act as binders. The binder chosen is the determinant of the color of the brick, generally imparting a red or yellow shade. Common bricks are made from clay alone without admixture of sand, the clay being its own binder. The color of common brick is imparted by impurities in the clay. Until recently almost all bricks were made by hand, the clay, sand, and binder being moulded to the form of a brick in an iron or wood frame. After drying in air or artificial heat the moulded product was fired, using wood, coal, natural gas or producer gas, depending upon which was most abundant and cheapest. Firing served to drive off the water and fuse the chemical constituents which the brick contained, and also, by the care with which it was done, it affected the hardness and color of the brick. The common brick composed of one material, of course, has no fusion in firing. Under

primitive conditions, the firing-sheds were not permanent and their operation was slow, irregular, and uneconomic, while their product could not be standardized in the slightest degree. These conditions still prevail in most regions where brick-making is conducted on a small scale. Where the business is more developed, a permanent kiln is installed into which moulded bricks are piled and then fired. Many such kilns are so arranged that the process may be continuous. Wherever they are used the usual fuel is gas.

Costs.—In the manufacture of bricks two costs stand out as the most burdensome, one for labor and the other for fuel. Inasmuch as brick-making is generally a seasonal or summer occupation, it seldom collects a permanent working force but must depend upon "floaters" to carry on the jobs. Lack of continuity of operation, added to untrained, ever-changing labor, generally results in small-sized brick plants; for example, the average number of people employed per plant throughout the United States is only 18. The lack of experience or sustained interest upon the part of most of the employes makes the labor cost per thousand bricks comparatively high. The other important cost item is the fuel used for firing. Since the firing takes from six days to two weeks, the availability, price, and economic use of fuel are important determinants of the success or failure of the enterprise.

Location of Brick Plants.—Brick manufacture reaches its greatest proportions either where wood is scarce or where density of population makes wood unsafe or structurally impossible. Where wood is lacking, brick and stone become the principal building materials. Babylon, the reigning city of semi-arid Babylonia, constructed her palaces, temples, marts, and homes from brick and stone, and from the ruins the modern towns of the neighborhood cull bricks for their own use. Treeless Egypt combined utility with art in rendering bricks of service. We are reminded of her industry in the story of the Pharaoh whose exactions culminated in requiring his Hebrew slaves to make bricks without a binder, an order that precipitated the Exodus. In the southwestern parts of our own country, in our own times, the

rule holds good that where wood cannot be secured, houses are made of brick. The adobe houses of that region are made from sun-dried clay.

City Markets.—In modern times, however, the regions which offer the best market for bricks are not so much those where wood is deficient but those where population is massed. Among nations this is seen in the prevalent use of bricks in Holland and Belgium. City contractors have learned that tall buildings cannot be made of wood alone, and city landlords have discovered that wooden dwellings are dangerous fire hazards. London was a city of wooden houses until the great fire of 1666, which showed the fallacy of inflammable material and led to the recasting of London into fire-resisting brick.

In the United States the same truth is also clearly manifested by the strikingly close correspondence between the counties containing our largest cities and the counties reporting the largest brick production. Cook County, Illinois, in which is the city of Chicago, is the largest brick manufacturing locality in the United States. In the East, New York City is the largest market for bricks; consequently, we find a concentration of the industry in the Hudson River Valley, so that every day barges full of bricks may be seen floating down the Hudson to the metropolis. Water transportation to New York City along Long Island Sound has made Connecticut also important in brick production. A similar explanation holds good for the brick made at Raritan, New Jersey.

The third most important locality in the manufacture of brick is the region in and near Philadelphia. This city claims to have had the first brick house in America, built in 1633 by William Penn as a gift to his daughter. The house still stands as a historical curiosity in Fairmount Park. The bricks of which it was constructed, however, were imported from Holland. As much of the soil upon which Philadelphia rests is clay, the city itself contains a great many brickyards. Its needs are also supplied by other yards on its outskirts. Philadelphia advertises itself as the "City of Homes." The houses that constitute these homes are 2½-story dwellings, built in rows and made of brick. Houses

of this type all nearly alike cover acres and acres of ground in West Philadelphia and North Philadelphia. Similar dwelling-houses may also be seen in Baltimore.

Substitution.—The brick industry recently received a blow when the popularity of concrete invaded the field so long dominated by brick. After the first decline in the face of this competition, the brick-makers were spurred to great activity in advertising their wares, in improving the quality of their products, and in educating the market as to the usefulness of their commodity. Latterly, the advance of concrete has been a direct stimulus instead of a check to brick manufacture, because bricks have been used in connection with concrete to lend it variety, beauty and mutability.

Another factor that has caused owners and builders to seek substitutes for brick has been the exactions of the bricklayers' union. The building trades, as a whole, have imposed more rules and exactions than unions in other crafts. Of the building trades, the bricklayers share with the plasterers the distinction of being the most autocratic and dictatorial in their dealings with employers. The latter in desperation have favored the use of materials that these two unions did not control.

Clay Industries: 2. Pottery

Early Prejudice.—Although pottery is an ancient art, having arisen in Assyria, Egypt or China, it was not common in the United States until after 1700. The early settlers of this country used wood or pewter household utensils to such an extent that before 1776 very few of the people outside of the largest places had ever seen porcelain. In 1825, however, a few pioneers in the industry began to send out their wares from their kilns in Jersey City and Philadelphia, followed 27 years later by the potters of Trenton. There was so much prejudice, however, against all American pottery objects that the first promoters found the utmost difficulty in securing a market for their wares and for the most part were forced to pass off their commodities as European products by placing English, French, or Austrian

labels upon them. The great awakening of pride in American-made goods which came with the exhibitions at the Philadelphia Centennial in 1876 marked the real beginning of pottery manufacture as an American industry.

Five Classes.—Of the five classes or groups into which pottery generally is divided, the first consists of white or decorated earthenware of which the most common, ordinary household utensils are made. This group comprises 40% of the total pottery output of this country and in its production Ohio leads by a wide margin, with West Virginia holding second place. Although chinaware is put in group 2, it requires so much slower, more careful, and skilful workmanship than is possible to secure with the high-priced labor of this country that we ordinarily have been content to import what chinaware we needed rather than manufacture it ourselves. Nevertheless, we have developed a considerable chinaware industry in New York and Pennsylvania. Sanitary ware, first developed at Trenton and for which that city is now most famous, comprises the third group. In the manufacture of this ware the United States leads the world. The fourth group is made up of all kinds of porcelain electrical supplies, which with the rapid increase in the popularity of electricity have experienced a notable expansion. Ohio and New Jersey are the centers of this particular type of pottery production. The fifth group includes all stoneware, yellow and red earthenware, and Rockingham products. It is the oldest branch of the pottery industry in this country and has been at all times localized in Ohio.

Rookwood Pottery.—One pottery, the Rookwood Pottery at Cincinnati, stands out as unique not only in our country but in all the world. This is the most famous art pottery in this country and it is a matter of pride to Americans that it has succeeded by depending entirely upon American materials and workmanship. Beauty, unusualness and art rather than economy in production or cheapness in price have been the determinants in its development. No printing patterns are used nor are any duplicates made; instead, the individual talent of each worker has been given free rein. As a result, in this pottery there have

been invented certain finishes and glazes that have never been imitated successfully elsewhere, although the attempt has been made at Sevres, Copenhagen and Berlin. Certain vases made at the Rookwood Pottery have a fabulous value. There are a half-dozen other art potteries scattered about the United States.

Advantages of Localities.—Of the two principal pottery states, Ohio and New Jersey, each has an advantage which the other does not possess. In Ohio fuel is so much cheaper than in New Jersey—costing less than half as much, as a rule—that Ohio has been able to maintain first place for most of the branches of pottery manufacture, with East Liverpool as her most intensely localized pottery center. Ohio, too, is near the center of population and hence has easy access to the markets. This factor is especially important in explaining her leadership in the manufacture of drain tile, for which the Middle West has a great demand. On the other hand, New Jersey has an advantage in being near the ocean, so that she can import by water materials from abroad at a saving of \$2 or \$3 a ton under the costs in Ohio; accordingly, wherever imported material is of consequence, New Jersey may lead Ohio, as she does, for instance, in the manufacture of sanitary ware. Trenton is the leading eastern pottery city.

Inefficiency.—In general, it may be said that the potteries of the United States were poorly located, badly arranged, and not managed to the best advantage. Too frequent recourse was made to foreign raw materials, whereas with a little study American raw materials could have been obtained with a considerable saving. Quite contrary to the usual rule, also, American potteries made less use of machinery than have those abroad, although our labor costs were higher here than in other nations. The consequence was that the lowest cost of production found in the United States was higher than the highest known in Europe. On the other hand, American manufacturers had a competitive superiority by reason of the custom duties, transportation charges, breakage, and other incidental expenses to which imported wares are subject. Our labor, too, although most costly, was more

efficient than that abroad and our cheap fuel permitted a saving on the average of \$1.25 a ton under the fuel charges in foreign potteries. Therefore, despite the disabilities of our potteries, their products could be placed upon the domestic market in direct competition with foreign-made goods and, as a matter of fact, American potteries slowly but surely were turning back the flood of foreign goods and grasping the American market for themselves.

To the generalization regarding the inefficiency of American potteries there are two exceptions. Since 1915 the plants producing sanitary pottery, such as wash bowls and closets, have been reorganized and technically revolutionized. Likewise, the plants that manufactured electrical fixtures began as early as 1910 to utilize machinery for the production of large quantities of standardized commodities. In each of these branches of the pottery industry the clay mixtures were treated chemically so as to flow without filtration through pipe lines to machines having cast molds made of plaster of Paris. These molds readily absorbed the water of the clay mixture and gave the clay the desired shape. Moreover, the old-fashioned kiln was abandoned by the makers of sanitary ware and porcelain fixtures. In its place was installed the new tunnel kiln the first of which was introduced into America in 1912. The tunnel kiln is an oven 300 to 500 feet in length with the fire zone in the central section. The ware to be heat-treated is passed slowly through the kiln on conveyors.

The introduction of these technological improvements has progressed rapidly since 1922 with the result that the output of sanitary ware was three times as great in 1925 as in 1914 and the production of porcelain electrical fixtures was increased five times in the same period. Another consequence of the changes is the ability of American producers to export their ware in competition with the production of European plants, which hitherto had had an advantage in cheap labor and greater use of machinery.

Organization of Workers.—No discussion of American potteries is complete without pointing out the peculiarly strong position long held by their labor force. In part, the dominance of labor was due to the circumstance that our business was conducted

more largely by male employes than was the case in any foreign plant. In the American potteries prior to 1910 men comprised 80% of the working force, whereas in Germany they were 65%, in Austria-Hungary 59%, and in England 50%. The preponderance of men workers together with the great skill required of potters led to a powerful labor organization among them, so vigorous and impregnable that the conditions of labor, the use of machines, the limitation of apprentices, and the elimination of female competition were rigidly controlled by the union and not open to free direction by the manufacturers. Although throughout the industry the open shop nominally was recognized, the actual fact of the situation was that most of the plants employed 100% union men. In this industry, as a consequence, we had the rather unusual arrangement of a national trade agreement between a national association of pottery manufacturers and a national brotherhood of operative potters. There have been few industries in this country wherein labor was sufficiently powerful to negotiate national trade agreements.

The technological changes made in the sanitary and porcelain electrical fixture divisions of the pottery industry were installed against the opposition of labor. Although the machinery is as yet too new to have demolished the union, it already has weakened the control of the industry by labor and foreshadows a still greater emasculation of labor power. The machines permit large-scale capitalistic operation of potteries with semi-skilled or trained labor. These matters betoken a new era in the pottery industry.

CHAPTER XXII

GLASS

Foreword.—Glass manufacture is one of the oldest crafts in the world. It was the first manufacturing trade introduced in America, for it appeared in Jamestown soon after 1607. Yet this first craft was the latest to use machinery, and despite the shift to machines after 1900, even today much glass is made in essentially the same manner as at Thebes in 3500 B.C. The oldest American mechanical art is the youngest American machine industry; literally, the first has been last. As a craft, glass-making was one of the most selective in the matter of labor and the workers who could fulfill the requirements were the aristocratic among skilled men. Today, however, some modern glass-making machines run without any attention except an occasional adjustment, so that labor is the least consideration. Labor, once mighty in the manufacture of glass, may in certain plants be given less consideration than the oil that lubricates the machines. This complete reversal took place in a span of twenty years after 1900. Hence, in many ways glass manufacture is the most fascinating of all our industrial enterprises.

Origin of Glass Manufacture.—Savants disagree as to whether glass manufacture originated in Asia Minor, Arabia, or northeastern Africa. Tyre, Sidon and Thebes all are mentioned as possible cities where the industry began. Legends attach the accidental discovery of glass to Phoenicia; both Tacitus and Pliny retell the story that a casual fire raging on sand and blocks of "niter" (potassium nitrate) produced a transparent liquid that astonished the beholders. But modern chemists deny that glass could have been made in the open by any ordinary fire. It is certain that glass was made in, or for, the city of Thebes as early as 1500 B.C., for excavations have brought to light glass

goblets and beads now reposing in museums, whose dates are fairly revealed by inscriptions on the objects themselves. Moreover, there are pictures of glass-blowers at work carved on Theban monuments which some authorities attribute to 3500 B.C.

Glass was a well-known valuable commodity in Egypt when that country was conquered by Caesar Augustus in 26 B.C. Part of the tribute levied by the victor was the prized glass. Taken to Rome, this glass was so much desired that orders passed back to Egypt in such amounts as greatly to stimulate the artisans. Eventually, certain influential Romans induced or compelled Egyptian glass-makers to migrate to the Imperial City, where natives were taught the art by the alien craftsmen. In its turn Rome not only equalled but surpassed Egypt in the glass produced, and then carried the art to the conquered provinces that later became France and Bohemia.

When the Roman Empire was shattered by the Goths the glass trade moved with Constantine First to Byzantium, the present day Constantinople. The torch of science and art was kept alight in the east while ignorance quenched it in the west. Europe for a time lost all knowledge of the craftsmanship of glass.

It was not until Venice, battenning on the Crusades, learned from her commercial scouts the eastern art of glass manufacture that at the end of the 13th century the craft returned to Europe. The island city was jealous of all her manufactures and commercial commodities, and threw safeguards around them to preserve them for herself. In keeping with this policy, the Venetian glass-makers, artists of the first rank, were practically imprisoned on the island of Murano, which was separated from Venice by a narrow channel. But no man, no nation ever has succeeded, in the long run, in the attempts to monopolize manufacturing secrets. The Venetian methods of glass manufacture leaked to the Teutons and French in the 16th century. In central Europe, Bohemia, in the 17th century, became the most noted glass-maker, while in the west both France and Belgium not only became producers quantitatively of common wares but were unexcelled in certain high grade quality objects. For example, France was most zealous in obtaining by devious methods the Venetian secret for the manufacture of glass mirrors to replace polished metal, and

having succeeded, went beyond the Venetians in the manufacturing processes, and hence the quality of articles turned out. In 1699 one small Venetian mirror was worth an estate, but by 1705 large French mirrors sold for \$500. The mirror of Marie de Medici, which hangs in the Louvre, was valued in 1791 at \$30,000 in gold, but much of this is attributable to the frame rather than the glass. The Hall of Mirrors installed at Versailles by Louis XIV was a vainglorious boasting of national prowess.

Glass manufacture did not cross the English Channel until Queen Elizabeth induced Cornelius de Lannoy and Jean Quarre to settle in her domain and teach her subjects an art that was both useful and luxurious.

Glass-Making in Colonial America.—Under all the circumstances both as to the novelty of the industry in England and the raw wilderness in America, it is remarkable that a glass works was erected at Jamestown about a mile outside the stockade, almost immediately after the settlers reached there. It is not surprising that the business was abandoned shortly after it was started. However, since glass beads were a valuable article of trade with the Indians, a second glass works was erected in Virginia in 1621, Italian workmen being imported to operate it. This one, together with the original works, was destroyed in the massacre of 1622; the business was not revived in Virginia until after it had been well started in several other colonies.

Glass works appeared in Massachusetts in 1639 and in the other colonies as follows: Pennsylvania (1683), New York (1732), New Jersey (1739), Connecticut (1747), and New Hampshire (1779). These plants produced goblets and other table ware, bottles and some window glass. In none of the colonies was the industry extensive either in number of plants or quantity of output. The product had a limited sale in the larger towns but none in the interior. Its costliness and fragility barred its use by common people or beyond the confines of the larger places. Metal, wood and leather furnished the ordinary tableware, while window spaces were closed by solid wooden shutters, in some instances supplemented by the European practice of using oiled paper.

Of all the colonies glass manufacture was most prominent in Pennsylvania. Nearly all the works clustered about Philadelphia, and those in western Jersey also served the Quaker City. A plant built in Glassboro, New Jersey, in 1775 by Casper Wistar, was still in operation in 1927; it was the oldest continuously operated factory in America. The reason for the eminence of the craft close to the one colonial metropolis was the larger number of families there who could afford the costly glass; just as today gold dinner sets are more usual in New York City than elsewhere in the nation. Then, too, there were more glass blowers among the German migrants to Penn's colony than in the British colonies, because at the time Germany was ahead of Britain in the industry.

One of the glass works of Pennsylvania is notable because it was associated with the romantic Baron Stiegel. The plant was on his estate at Manheim and was operated in 1769 by workmen whom the Baron secured from Germany.

A Century of Handicraftsmanship.—For a hundred years after 1770 glass manufacture flourished as a handicraft with only slight technological changes. Indeed, a resurrected Theban g'ass blower could have entered most any American glass bottle factory and been quite at home after the lapse of 5,000 years. But there were two branches of the industry in which the Egyptian would have needed a little instruction. These were the pressed glass and plate glass divisions.

Deming Jarves, a carpenter of Sandwich, Massachusetts, discovered in 1827 a method for pressing glass in a mould to the desired form and size. This saved part of the operation of forming the object by the skill of the blower and yielded products of much greater uniformity. Moreover, designs could be included that resembled those produced by expensive etching and grinding. Sandwich immediately sprang to the front in glass manufacture and today Sandwich glass of this early period is zealously garnered by museums and private collectors. At the time pressed glass was confined to tableware and was used solely for the common grades of goods. Pressing by moulds did not release the manufacturer from the need of employing the highest

skilled manual labor but the process was the first tentative step toward a machine age.

Although plate glass was first made in the United States at Brooklyn in 1852, it was not until 1869 that John B. Ford made the first earnest attempt to manufacture this product. It was twelve years later before plate glass was a commercial success. Since then, however, its manufacture has been so perfected that it is a serious competitor of window glass.

During the century before 1870 the glass manufactured was shaped into bottles, flasks, tumblers, lamp chimneys, and the like in one division; into window glass in another; and tableware by the pressed method, in a third. The works concerned with all three divisions were similar in outside appearance and in inside equipment, and all were influenced by the same set of economic factors.

The factories, as a rule, were low, wide, roughly constructed wooden shacks. Inside were two essential pieces of equipment, one a furnace, the other a reheating oven. The furnace was a brick affair formed somewhat like a gigantic lamp chimney, of which the narrow upper part extended above the roof. The wide base had space inside for clay pots around which played a fire of wood or charcoal. The pots contained the mixture or "batch" of silica, and an alkali, of which glass was composed. Modern commercial glass contains a third ingredient, a metal such as lead, zinc or aluminum. The reheating oven (called leer or lehr) was a long brick box in which the finished glass article was brought almost to the melting point and then slowly cooled. This annealing was necessary for otherwise the glass after blowing would be cooled more rapidly on the outside than on the inside, and consequently would be so brittle as to break with the slightest shock.

Raw Material.—Silica in the form of sand comprised 50% to 75% of the mixture in the batch. The alkali used was generally the ashes of plants and seaweed but at present the source is the natural deposits or compounds of sodium, potassium and lithium, or alkaline earth bases, such as lime or barium. The metallic ingredients of the batch were lead, zinc or aluminum. The loca-

tion of raw materials has had but slight bearing upon the location of glass plants, for not only are the raw materials generously distributed, but their total cost is a slight part of the whole expense in manufacturing glass. A wide change in the price of raw materials is less important than a slight modification in wages or the cost of fuel.

✓ **Labor Aristocrats.**—The actual making of the glass object was entirely a matter of skill on the part of the worker. He collected a mass of molten glass on the end of a four foot hollow metal rod. By blowing through the rod and into the glass, and by swinging, elevating and rubbing he gave the glass the form desired.

Hence in glass manufacture the first item of primary importance was a body of skilled labor. The physical requirements of the manufacturing operations were of considerable importance in restricting the number of men who could perform them. A glass blower had to be active on his feet, strong in his back and arms, able to withstand excessive heat, and with all these characteristics must have powerful lungs. Since few men could be found with these capacities the ranks of glass blowers were necessarily limited. This gave the privileged few an opportunity to ✧ organize into strong craft unions whose rules heightened the rarity of glass blowers. As a consequence, glass blowers were the aristocrats among American workmen. Their average wages ✕ were 12 times the wage of common labor and some blowers received 20 times as much as common labor. Moreover, at the time other skilled crafts were battling to reduce the hours of labor from 12 to 10, the blowers enjoyed an 8-hour day. Besides, they had a full two months' vacation during the hot months of July and August.

Fuel.—While the cost of labor accounted for half to three-quarters of the total expenses of glass production, the charge ✧ for fuel was a third to a half of the remainder. Wood at first was the universal fuel in American glass factories and in the form of charcoal it continued to be important until about 1870. Just as in 17th and 18th century Europe, glass was made always

in forests, so, too, in 19th century America, the factories kept close to the wood supply. Because the plants were small, and were without expensive machinery, the business was moved when a local wood resource was exhausted. The migration was not far but hovered in the same general locality where the labor was found.

Of all the states where wood was the fuel, New Jersey became the most noted glass-maker. Glassboro, Millville, Bridgeton and Vineland were the centers where the greatest number of highly skilled glass workers lived, having grown from the nucleus of the plant at Glassboro established in 1775. That section of New Jersey was forested, and also was within easy reach of the forest resources of eastern Pennsylvania. For a century this glass producing region claimed supremacy in quality of output.

In quantity it was overshadowed by the plants that used coal fuel. Albert Gallatin was the first man to locate a glass factory in accord with coal fuel. His venture, begun in 1787, was on the Monogahela River about 60 miles above Pittsburgh. The first glass house in Pittsburgh itself was built in 1795 and known as "Scott's." Both these pioneer ventures produced window glass. The real promoters of the glass industry west of the Alleghenies were General O'Hara and Major Craig, whose first plant was erected in 1797. The success of these men attracted other glass-makers to Pittsburgh so that soon a coal-glass industry in the "west" rivalled the wood-glass industry of the east. As wood got scarcer and higher priced, the expansion of the glass industry took place near the soft coal fields. The older eastern plants held their business and even increased it, but the real growth of the industry took place where coal fuel was most abundant and cheapest. Pittsburgh became the leading glass producer.

In 1859 Colonel Drake discovered petroleum in Oil Creek in western Pennsylvania, and the successive oil booms followed. This set of events was important to the glass industry in two ways. First, the earliest great market for petroleum was the refined product, kerosene, used for an illuminant. The use of this light called for lamps and chimneys. The lamps were made of other materials as well as glass, but the chimneys always were

of glass. The boom in the illuminating field was felt as a great stimulus to glass houses. The coal-fuel glass houses were the ones that paid most attention to the new business of making lamp chimneys. But the second influence of the petroleum industry was to cast out coal as a glass-making fuel. Natural gas was found to be the ideal fuel for this industry. It was ridiculously cheap, easily controlled, and far cleaner than coal. The reason charcoal competed favorably with coal for so long was that it had no smoke, nor gases deleterious to the quality of the glass. Natural gas, although not so clean as charcoal, was much less injurious than raw coal, and notably cheaper than charcoal. Natural gas fields, therefore, became the most powerful attractions to glass-makers.

Since natural gas is an ephemeral resource, dependence upon it in any one place is illusory. Fortunately, the glass plants were small, with slight capital investments, so that their owners could follow the gas fields from place to place. Thus they travelled from Pittsburgh to Indiana and back to Ohio, West Virginia and Kentucky. Those glass-makers who could not or would not travel about in the wake of gas well discoveries were forced in competition with the cheap gas to abandon both charcoal and raw coal fuels. They, too, were compelled to use gas, but of a kind produced by the distillation of coal. Since this was more expensive than natural gas, those who used it had to make quality glass or some patented glass article such as the Macbeth "Pearl Top" lamp chimney.

Crude oil has not been satisfactory as a glass-making fuel for it has all the evils of raw coal in an intensified degree. Electric heat would be ideal for glass manufacture but it has not had extensive application because it has been altogether too costly to compete with natural gas or distilled coal gas.

The Continuous Tank.—The first change in glass technology occurred after 1870 when the need to meet the keen competition induced by the sectional distribution of glass plants, together with the use of new fuels, turned manufacturers' attention to improvements in furnaces. With raw coal or wood direct firing only was possible but with easily controlled gas the regenerative reverbera-

tory furnace was possible. The term "regenerative" refers to the fact that the waste gases of combustion can be run over loosely piled fire brick which absorbs the heat, and then the incoming air and fuel gas turned through the bricks so as to be preheated before combustion. This method, conserving fuel and reducing the time for melting, is economical in two ways. The term "reverberatory" is symbolic of indirect heating, for the heat is applied against a curved roof which reflects it upon the object heated just as a reflector guides a beam of light. By indirect heating in glass manufacture the danger from impurities in the fuel is reduced, for the fuel and its combustion does not come in contact with the "batch" of glass raw materials. Thus *regeneration* is economical, and *reverberation* is cleanly.

The principles involved in the above were introduced in Germany in 1861, and applied in America in the seventies. American glass manufacturers, however, contributed the next advance made possible by the German innovations. This step was the abandonment of pots in favor of the making of glass in one great tank. The first tanks had three divisions: one for melting the batch, another for refining it, and a third for holding the purified glass. Later the divisions were removed and the results gained by depressions opposite each opening where the glass was removed.

The regenerative reverberatory gas fired tank permitted continuous 24 hours production instead of the intermittent output with pots which had to be refilled. Moreover, pots themselves were extremely expensive to manufacture and were very short-lived. They wore out or broke in less time than it took to make them. Since the tank discarded pots it removed most but not all of this expense. The tank was essentially one gigantic pot lined with the same material of which pots were made and hence subject to destruction.

The continuous tank replaced pots in all efficient factories except those that made plate glass, superfine tableware, and a diversity of colored ware. The continuous tank, although a new machine, was of benefit to labor. It saved all the time lost in filling or changing pots and permitted the use of a shorter blowing iron. Both of these economies were translated into greater output in a given time. The worker, being paid on the piece basis,

thus earned more in a day, while at the same time his employer gained a greater number of units for a given expenditure. The workers added still more to their earnings by introducing, after 1870, what they called the "shop system," which really was a gang system within which there was a subdivision of labor. Instead of the single blower a "shop" comprised three men, two of them gathering the glass and blowing, while the third smoothed and finished the article and started it to the annealing oven. "Shops" were not invariably of the sort mentioned but were of many different combinations. While the workers produced and earned more by the "shop system," the employer was aided because of the inclusion of apprentice boys in the "shop" for the simpler operations. The apprentice, of course, was paid less than the skilled blower. The employer likewise benefited by the increased output.

But the continuous tank, apparently so beneficial to labor, prepared the way for other inventions that toppled labor from its lofty golden throne.

Glass-Making Machinery.—The glass industry has four main divisions: first, the bottle business, which accounts for most of the total value of glass produced; second, building glass; third, plate glass; and lastly, blown and pressed ware. The bottle division comprised druggists' containers of various kinds and sizes, the bottles for drinks—hard and soft—milk bottles, fruit jars, bottles for patent and proprietary goods, containers for packers and preservers, demijohns and carboys. Building glass includes window glass, obscured glass and wire glass. Blown and pressed ware embraces tableware, jelly glasses, tumblers, goblets, lamps, lanterns, chimneys, globes, bulbs for electric lights, glass fixtures for electricity, gas and candles, opal ware, cut ware, tubing, and decorated glassware.

It has been chiefly in the manufacture of bottles and window glass that machinery has been introduced, these two classes of glass exceeding all others in quantity and value of product. Nevertheless, rudimentary machinery has appeared in other branches of the industry and betokens for the future a much greater application of mechanism.

Bottle-Making Machinery: 1. The Owens Automatic.—For making bottles two types of machinery have appeared: one, the Owens automatic machine; the other devices called “flow” machines.

Michael J. Owens, of Toledo, Ohio, in 1903 invented a machine for making bottles with a wide mouth and throat. This machine gathered exactly the right amount of molten glass by a suction connection and then formed the bottles in molds, the glass being blown by compressed air. This machine performed automatically every operation formerly done by blowers or a “shop” of workers. No skilled labor was required for the machine and no labor at all except for an unskilled watcher. By the handicraft method the labor cost in making bottles was 50% to 75% of the wholesale price of the product but by the Owens machine the labor cost was so small as to be negligible.

The first Owens machines had four or six arms, one mould to an arm, and were limited to large necked bottles. Quickly, more arms up to fifteen were added to the machine and as many as six moulds were carried on each arm. Moreover, the machine was adapted to produce bottles with any size opening, any shape or any capacity. The machine was run 24 hours a day and by 1917 was capable of producing from 75,000 to 288,000 bottles per day. Less than 200 of these machines in 1927 were capable of turning out about half of all the bottles used in the United States. Put in another way, these few machines had the capacity to make about a quarter of all the glass manufactured in the country.

Bottle-Making Machinery: 2. Semi-Automatic and “Flow” Machines.—Beginning in the late 80's, experiments were made with machines that automatically blew a bottle in a mould by means of compressed air, but the machine was not completely satisfactory until 1898. With these machines a skilled operator was required to gather the proper amount of molten glass at the furnace and to drop exactly the right amount in the mould. Since skilled men were needed for the preliminary operation these machines were called “semi-automatic.” At first, only wide mouthed ware could be made with these devices, but in 1908 even small prescription bottles could be produced. By 1900 about

100 semi-automatics had been installed in glass houses, and after the improvement made in 1908 the number of machines doubled. Beginning in 1914 the superiority of the "automatics" caused the semi-automatics to lose ground, so that in 1920 the number was about the same as at the opening of the century, and five years later had shrunk to about a score.

Meanwhile, inventors had wrestled with the problem of displacing mechanically the skilled gatherer needed for the semi-automatics; that is, of feeding the moulds automatically with proper amounts of molten glass. Inventions in this process were classified as "feed and flow devices," or more simply as "flow devices." The first patent for a flow device was issued in 1903 to Homer Brooks. Other manufacturers worked on the problem and in 1916 there were 12 establishments that had machines for this work. In 1921 there were 36 plants using 104 flow machines, and in 1924 the number had been increased to 260 machines in 41 factories.

The first semi-automatics required two skilled men to make wide mouth bottles. In 1908 the narrow neck bottles made on semi-automatics required three skilled men. Four years later the wide mouth bottle machines could be run by one man, and the same was true for narrow mouth bottle semi-automatics after 1914.

Effect of Owens Automatic on Labor.—Apparently the Owens machine had the power to drive out all skilled men from the glass bottle industry, but this did not occur. The owners of the new machine preferred to use it themselves and to lease it to a few other privileged manufacturers rather than to manufacture the machines in quantities for sale to all bottle makers. That is, they chose to take profits from the product of the machine rather than from the sale of the mechanism itself. Since the machine was very expensive and most glass factories operated on a small scale, it is probable that the Owens Bottle Machine Company could not have sold enough machines to realize a profit.

Choosing to make bottles with its machine, the Owens Company seemingly might have destroyed all the manufacturers employing handicraftsmen, doing so by cutting the price of bottles

below the cost of production in the old fashioned plants. But the Owens Company made the most money by letting the price of bottles stay at the point fixed by the cost of production in the older factories. Moreover, the Owens Company, although it dispensed with the cost of skilled labor, added almost as much in interest charges on the capital invested in the costly machines. That is, the old way of making bottles was expensive in labor and cheap in capital, while in the Owens Company the reverse was true. The total costs of either group were not so extremely far apart. Hence the Owens Company was wise in adopting a policy of "live and let live" and philanthropy was not the sole basis for the policy.

Yet the Owens Company and its licensees did dispense with skilled labor. The output of the group accounted for about half of all the nation's bottles in 1927. How then did skilled labor escape doom? The answer lies in the unprecedented increase in the consumption of bottles after 1900. The sale of milk bottles tripled between 1904 and 1914; the demand for bottles from packers and preservers almost doubled, and the consumption of bottles by producers of soft drinks, and by druggists, added from a half to three-quarters of their former demands. From 1914 to 1927, despite the effects of the Volstead Act, a similar story was true. That is, about as much business remained to the manufacturers by old methods in 1927, after subtracting all the product of the Owens Company, as the manufacturers had enjoyed in 1900 before the Owens machine entered the industry. Nor is this the whole tale. The machine by its nature made standard products and was most profitable when run on large orders. On the other hand, there were many bottle buyers who not only demanded individual sizes and shapes of bottles but placed orders for small quantities. This business fell to the handicraft factories. These plants, too, garnered many orders because of the advantageous location close to consumers. Hence the labor displaced by the Owens machine—54 to a machine—was absorbed in the expanded business of the older branch of bottle manufacture. This eased the shock of the machine.

Effect of the Semi-Automatic Machines on Labor.—The semi-automatic machines were not so drastic in displacing labor

as the Owens automatic. Prior to the introduction of flow devices—that is, before 1916—from one to three skilled men were required to operate each semi-automatic machine. Notwithstanding this retention of skilled men, the unions in the bottle industry had to modify their policies because of the influence of the machine. In the Owens plants with one exception the unions never have had a foothold, but in most of the plants using semi-automatics the unions were powerful in the days of handicraftsmanship and have retained much of their authority by adapting themselves to the new mechanism. First, the unions made it a policy to limit apprentices so as to retain as many jobs for the journeymen as possible; and secondly, they adopted the policy of three shifts which, of course, calls for a third more men. Because the semi-automatic favored skilled men more than the Owens machine, the unions cooperated as far as they could with the manufacturers who installed the semi-automatics so that these employers could compete with the Owens group. Finally, to keep alive the oldest pot furnace plants employing hand blowers in competition with both types of machine using factories, the piece rates were cut for bottles made by hand.

With the adjustments in rates necessary for the semi-automatics and the cuts in the handicraft factories, the net result has been a drastic reduction in the wage of glass blowers as compared with other skilled crafts. Whereas the average wage of blowers before the introduction of machinery was \$10 to \$12 a day, the average wage in 1927 hovered between \$6 and \$7 a day. From 1915 onward, when all other skilled crafts were increasing their money wage by a substantial amount, the glass blowers were submitting to reductions.

Probably the actual number of master craftsmen in the glass workers unions was as great in 1927 as in 1900 but in the face of the great expansion in the industry this represents a relative displacement of startling proportions. The future foreshadows no silver lining to the cloud that lowers over skilled glass workers.

Machinery in the Window Glass Industry.—The traditional method of making window glass was to blow a bulb of glass, open the bottom of it, and then flatten the edges into a disc. This

was called "crown glass." If the circular sheet was squared and sold intact it had a thick, partially opaque center where the original bulb was attached to the blower's tube. To eradicate this bull's eye, or crown, the disc was cut through the center and each half-circle squared. Of course, by this procedure, only small panes were possible.

About 1830 the Italians invented the cylinder process of manufacturing window glass. A ring was dropped into a vessel of molten glass, and the ring slowly raised. As it was lifted it pulled upward a cylinder of glass held together by capillary attraction and viscosity. At the proper time the cylinder was detached from the ring, the cylinder slit, and the edges flattened into a sheet. This process passed from Italy into France and then to England. In connection with the process, the tank furnace was introduced to enable large cylinders to be drawn.

Although we adopted the cylinder process we adhered to pot furnaces until 1888, and, in consequence, our window glass was of poor quality and in small sizes. In fact, we imported fully a quarter of all the window glass we used. In the year named, James Chambers, after studying the most advanced European window glass manufacturing methods, built a plant at Jeanette, Pennsylvania, which was highly successful.

The cylinder method suggests mechanical manipulation but it was 1903 before any cylinder machine was invented in America. The Lubbers machine of that year was purchased by the American Window Glass Company and installed at Alexandria, Indiana. It was two years later, however, before the machine was a commercial success.

The Lubbers machine was followed by several others, among them being the Healey, Frink, Douchamp, Douchamp-Henshaw, and Okmulgee. These machines after 1905 practically supplanted the older processes in number of square feet of glass produced, notwithstanding that as late as 1917 there were about three times as many establishments making window glass by hand blown process as by machine.

In 1916 the Owens Bottle Machine Company acquired the Colburn patent for drawing continuous flat sheets of glass. In

this process a bar of metal—called the “bait”—is inserted in molten glass and drawn upward over a roll. The glass is gripped at the edge and moved forward in a continuous flat sheet toward and through the annealing oven, the “bait” being removed. After once started, this process may produce glass by the mile. Potentially, it can obsolete all cylinder machines and cylinder blowing by hand.

Effect of Window Glass Machinery upon Labor.—So long as the only machines for making window glass were of the cylinder variety the only labor displaced was the hand blower; but his job was performed by a skilled machine operator. Inasmuch as the machine was far more productive than the hand blower it bade fair to delete this artisan. However, the glass trade believed that hand blown sheets were of superior quality to the machine blown, so the hand blowers were retained for quality products.

The Colburn machine does away with blowers and all subsequent handlers. Consequently, it challenges labor and manufacturers using the older method, just as the Owens Automatic Bottle Machine did in its branch of the glass industry.

Machinery for Making Other Glassware.—Although machinery made its first great inroad in the glass bottle and window glass divisions of the glass industry, it also began to invade other branches after 1900. The plants that produced glass tableware and those that made lighting equipment, particularly electric light bulbs, were not far behind in the development of machinery. Wherever the new machines appeared they were equally disastrous to labor.

For example, one department of the tableware mills was called the “white liner” branch. In 1907, the workers in this department earned from \$7 to \$11 a day, and produced about 500 articles per hour. An automatic machine, introduced first in 1908, was capable of turning out in 1928 not less than 7,200 articles per hour and eliminated all the skilled and unskilled labor. Likewise, an automatic machine for producing electric light bulbs perfected in 1920 had a capacity for 73,000 bulbs for 24 hours in 1928 and did away with 994 men. The most advanced of these

machines can produce 147,000 bulbs each 24 hours. The labor cost per thousand bulbs by utilizing these machines was reduced from about \$13 per thousand bulbs to less than a half-dollar per thousand. Still another machine for making tumblers such as are used for dispensing soda-water fountain mixtures, has displaced 80 men. Until 1919, glass tubing was manufactured expensively by hand, but in that year an automatic machine was invented that removed all need for labor in its operation. The output of this machine is as much per minute as a hand worker could produce in a day, and the machine could be speeded still more if the market existed to consume the output at the enhanced speed.

Glass Industry in Transition Stage.—That the glass industry is in a transition stage from hand to machine processes and from small to large-scale production is shown by the census data for 1925. In that year there were 310 glass-making establishments; of these, 88 had pot furnaces and 293 possessed either continuous tanks or tanks of the same kind that were operated intermittently, called "day tank furnaces." The discrepancy in the above figures is explained by the fact that 71 plants had both pot and tank furnaces. In the whole industry 100 establishments were equipped with fully automatic machines for blowing or pressing, 54 had semi-automatic machines of different kinds, while 29 depended upon hand blowing. There were 42 plants making window glass, of which 23 had installed machines. The plants having a product valued at more than \$100,000 have steadily increased in number, while those whose product was less than this figure have just as steadily decreased. The smallest plants with products valued between \$5,000 to \$20,000 have suffered the most rapid decline, while the largest with products worth more than one million dollars have enjoyed the largest numerical advances.

Another indication of the alteration in the industry is the record of installation of power prime movers. In 1914 the 2,290 prime movers in the glass industry were rated at 162,934 horsepower, whereas in 1925 the 8,795 prime movers had a horsepower of 271,639. That is, the power producers were smaller in

capacity but almost four times as numerous. Electric motors increased from 6,018 with a capacity of 92,896 horsepower, to 17,958 with a capacity of 259,167 horsepower.

Still another statistical evidence of the transition is found in the figures of wage-earners per plant and dollars of product per wage-earner. In 1914 there were 211 wage-earners per plant, and in 1925 the number was 201. The value of the product per wage-earner in 1914 was \$1,652, but in 1925 it was \$4,266. Allowing for the change in the value of money, the year 1925 showed an increase in dollar productivity per worker of 54%, a most significant figure.

Effect of World War.—When the World War gave American industry as a whole the most powerful dose of strychnine it had ever received, only a few grains were administered to the glass industry. Glass was less a war material than any of the other leading manufactures, and we neither bought nor sold much glass abroad. In the making of bottles we had no superiors, and our window, plate, and pressed glass were as good as any produced elsewhere.

But in the higher realms of glass manufacture we had been scandalously deficient. For optical glass we had depended largely upon Germany and for chemical ware we had rested confidently in the supply from Germany, Belgium, France and Austria. Glass for gauges in instruments, also, we had procured abroad. These very varieties of glass were the essential ones in prosecuting war, and they had been derived from the nations that were torn by armed conflict.

Consequently, between 1914 and 1920 we had to learn to manufacture kinds of glass that never before were made quantitatively in America. For these types the pressure created by the War, and the entire removal of foreign supplies, were a double incentive to our glass-makers to hasten to meet the demand.

It was fortunate that the glass industry had begun to shift from handicraft small-scale operation to machine production on a large scale. The small old-fashioned glass-makers, for the most part, did not and could not enter upon the untried, unknown output of the highest grades of glass. It was the large modern glass

plants that had the capital to indulge in experiments, and the laboratories, physicists, chemists and optical experts to conduct the researches. In addition, the large establishments had the means to produce in large quantities after the secrets of production were learned. The emergency compressed into a few feverish months the research and experiment that would have taken years under normal peace conditions.

As a result a few of our leading companies succeeded in making glass that was admirable for lenses of all varieties, from marine binoculars to light-house searchlights. Glass for gauges was also produced that was resistant to sudden changes in temperatures as well as prolonged abnormal temperatures. Glass to fill the millions of shell-rimmed frames that adorned the noses and aided the eyesight of America was likewise made available for the first time from domestic factories. Glass used in chemical and physical laboratories, such as beakers, cups and test tubes, which had to fulfill exacting requirements, was not only manufactured here for the first time but in quantities equal to the demand and in quality exceeding that of former foreign importations.

When the Armistice came, our glass industry was equipped to furnish every variety of glass demanded by American consumers. Human prejudice caused many buyers to return to European makers, but the majority—and all those who purchased by test rather than by whim—continued to support the industry which had thrust from timid infancy to confident maturity in five years.

Curiously, one of the by-products of the research in the realm of higher mathematics, optics and chemistry was a glass admired by cooks. This was a transparent heat-resistant material that the cooks, without qualm, could put both in the oven and upon a dining table.

Specialization and Large-Scale Production.—In each of the branches of the glass industry as a result of the transition in methods, one or more companies have attained the status of large-scale producers. When these companies possess but one plant they generally specialize upon one variety of glass, and in the

cases where subsidiaries are controlled, each usually confines itself to one or a very few types of products.

Illustrations of these facts may be found in the bottle branch where the Owens Bottle Machine Company dominates, in the window glass section where the American Window Glass Company is the leader, and in the plate glass division where the Pittsburgh Plate Glass Company is the most important factor.

On the other hand, there are a few large-scale companies that produce a wide variety of products. A case in point is the Macbeth-Evans Glass Company, with headquarters in Pittsburgh. This company, which started as a producer of lamp chimneys, now markets several thousand objects of pressed and blown glass.

At the other end of the scale in point of size, the little handicraft factories accept orders for almost any glass object that comes within the range of their division. That is, the bottle makers produce all sorts of bottles, and the pressed glass manufacturers will try to make any pressed article a customer desires.

This distinction between the handicraft and machine manufacturers is natural, for a skilled worker may turn his hand to a wide range of commodities, whereas a machine is most profitable when engaged upon a standard product.

Because it illustrates in our own day so many industrial and economic theories and facts that in other industries can be seen only by a historical résumé, the glass industry is one of the most captivating.

CHAPTER XXIII

AMERICAN LABOR

Introduction.—Production is cooperative. Goods are the resultant of the combined contributions of land, capital, business management and labor. In this fourfold cooperation labor has no fixed status, for the importance of labor varies between industries, and within one industry the place of labor is seldom the same in any two separate enterprises. Moreover, from one time to another labor has played different rôles, sometimes holding the spotlight, but at others relegated to a minor part. In the ancient flour mill the miller was the leading character, but workers in the modern Minneapolis plants are understudies to the machinery. In an up-to-date clothing factory the employes by their acts dictate success or failure, whereas the spinning rooms of a 1928 yarn factory are ruled by the machinery, not by the spinners. In potteries producing sanitary ware labor holds full sway but in potteries manufacturing electrical porcelain the machinery dominates the workers.

Yet, over the long years of the past down to the present, if all industries were lumped it would be found that the proceeds of the total output have gone to labor in much greater proportions than to any and all of the other contributors to production. Hence the story of labor is a vital part of the epic of industry.

Colonial Labor: Free.—The friends of Miles Standish and the associates of John Hancock solved their labor problem in the most primitive fashion. Each family produced its own labor, just as it depended upon itself for nearly all other commodities and services. Colonial labor was recruited from the family cradle. Large families were an economic essential, so that the mother of a numerous brood was not only honored but fulfilled the stern want for homestead labor. Childlessness was a menace to eco-

conomic security. Child-bearing added to the multifarious duties of a pioneer wife wore women to early graves. Child-beds were the altars upon which mothers were sacrificed to Necessity. Early burial grounds along the Atlantic Coast bear tragic witness to the toll taken of colonial women by overwork; like the Oriental, the colonial patriarch was buried among many consecutive wives.

The working days of a colonial child began before it got its second teeth and continued until the wrinkled skin puckered about toothless gums. To be sure, tasks were graduated to years but everyone was compelled to work up to full natural capacities. However, play sometimes entered into work. Tasks that the family could not manage with its own labor became community affairs, and such occasions took on the aspect of town picnics. When a barn or house was to be raised, and when corn was to be husked, the whole countryside assembled. Refreshments, both solid and liquid, were abundantly furnished, the guests often contributing these as well as their labor. Jollity more hearty than decorous lightened the hardest work and "a good time was had by all." Cooperative community labor had no small share in colonial economic organization. Echoes of this type of labor arrangement are to be found even yet in rural America.

Guilds.—The organization of crafts that prevailed in Europe at the time of Columbus was the guild. While Cabot, Gilbert and de Soto were exploring America, the European guilds were entering decline. In England the guilds were hampered from within by their own increased aristocracy and from without by the growth of trade and the solidification of the power of the king. During our colonial period the guild system in England was gradually decaying and upon its ruin the domestic system was rearing its head. Nevertheless, the craftsmen who emigrated to America were trained in the guild tradition.

Upon the western side of the Atlantic the craftsmen found circumstances ill suited to the re-establishment of guilds. The general practice of household industry left little opportunity for guilds to start; for town craftsmen did not furnish manufactured goods to dwellers in the country. In so far as men skilled in trades aided householders they did it by personal visit to the

family hearth. There were few large towns and no real cities where aggregations of men of the same craft might come together. The ambition of the craftsman was not to become a master but to be a landholder or a merchant. Individualism rather than collectivism ruled in the new country. So the guild organization never was notable in America.

Yet a few feeble guilds did appear. Among the shipwrights of New England there was an organization that smacked of the guild, and in Philadelphia a guild was formed among carpenters. The shipyards called together in one place many men of the same trade and their product did not compete with household manufactures. The same was true of carpenters, and Philadelphia, the home of their guild, was the closest approach to a metropolis in America. Boston, too, had an occasional temporary guild organization among certain skilled crafts such as shoemakers, and there was at one time a butchers' guild in New York. But these illustrations were not ordinary; they were produced by exceptional situations.

Colonial Labor: Bound.—Just as the guild was the contemporary European organization of labor in manufacturing, so the manor was the type for agriculture. Like the guild the manor was waning in England at the time America was settled. The Dutch patroonships, some of the features of New England town economy, and the definite manorial system attempted in Maryland were American reflections of a European agricultural labor organization. We have shown in Chapter I that these manorial seeds failed to sprout in America.

The most typical labor feature of the manor was that the villeins were bound to the soil. The villeins had rights and privileges but part of their labor and its fruit belonged to the manorial lord. One of the last relics of manorialism was the indentured servant. This system of labor flourished briefly in America, chiefly in the Middle Colonies and the South.

An indentured servant exchanged his labor and his liberty of movement for his keep. He was a temporary slave. American planters, experiencing difficulty in hiring free labor or in keeping it when hired, turned to the comparative security of the system of

indenture. British poor submitted to indenture to get passage to America, their bound services paying for transportation. German immigrants sold themselves under indenture in order to learn the ways of farming in wild America and also to gain subsistence while acquiring knowledge of English. The indentured servant was bound to the soil without pay for a term of years—generally seven—but was fed, clothed, and housed by his master during that time and when the term expired was given decent clothing and perhaps a little money.

In essence, the system suited the needs both of masters and men but in practice it was capable of vicious exploitation on the part of masters. It became a criminal scheme when ship captains or crimps kidnapped unwilling or unconscious victims in British cities, wafted them to America and sold them helplessly under indenture against their desires. The service period being limited, some masters sought to profit by merciless exactions during the bound time. On the other hand, the indenture system was sometimes misused by the workers. Crafty persons promised to pay passage by indenture but promptly decamped as soon as safely landed on an American farm.

Even when both the employer and indentured servant were just and honorable, the system was irritating. This, with the difficulties that arose when one party was not fair, led planters to approve outright slavery. Negro slaves were first sold in America in 1619, when a Dutch ship disposed of a human cargo in Virginia. But the slave system at first was not rapidly expanded. It was not until tobacco in Virginia and Maryland, and later rice and indigo in South Carolina, became standard crops that slavery mounted; not even then was slavery generally adopted until free labor and indentured servant labor were proved impracticable. The crops mentioned were grown on large plantations, gave constant employment throughout most of the year, and could be managed with crude labor. Hence they fitted into a system of slavery.

New England and the Middle Colonies had small farms, diversified crops, and long winters when slaves would cost more to keep than their labor repaid.

Although Newport, Rhode Island, and Charleston, South

Carolina, became recognized points for the import of negro slaves, the total number of slaves imported directly from Africa never was large. Instead most slaves for American use were purchased in the British West Indies, where slavery had been in vogue for a long time, so that slaves had been trained to field labor and had learned the English language.

The slave traffic, as distinguished from the slave system, was abolished by the English Parliament and by an American constitutional provision at about the same time. Yet as long as the slave system lived, the slave traffic continued illicitly.

World-wide experience with slavery proves that it is less efficient than free labor, is most profitable with agriculture, and that in agriculture it eventually destroys the land. Before the Revolution it appeared in the South that there was a double exhaustion of soil, one by the natural drain imposed by constant cropping with tobacco, a plant that consumes phosphorus, the most valuable and scarce element in soil fertility; the other a resultant of the crude, unintelligent efforts of slaves. The only basis at that time for the continuance of slavery was a successive exploitation of new land. Planters in Virginia and Maryland at the time of the Revolution were about ready to abandon tobacco production and the slave system together. This had political consequences when the Constitution was written. But when Eli Whitney patented the cotton-gin in 1794 he fastened slavery upon the South for another full generation. The incubus of slavery upon that generation, its far-reaching consequences, and the savage solution of the slavery issue, like John Brown's soul, still "goes marching on."

After the Revolution: Wage Reduction.—The dust hardly had settled over the field at Yorktown before American workmen became aware that industry and their place in it were changing. While household manufacture was still the rule, there were certain trades that had become prominent in New York, Philadelphia, Baltimore and Pittsburgh. Printers, shoemakers and carpenters were present in sufficient numbers in these larger places to have developed a degree of self-consciousness. Before 1800 the craftsmen in each city were affected only by the condi-

tions in their own city and were able to impose rules upon employers to offset their local circumstances. But after the opening of the century wholesalers appeared and rapidly gained ascendancy. These middlemen sold in a market rather than to a known customer, so that competitive price became a more important factor in sales than the reputation of a master craftsman. Wholesalers pitted masters against each other, first in one city and then in different cities. Masters who produced for the lowest price got wholesalers' orders. To make a profit at the contract price masters abrogated rules concerning the number of apprentices per journeyman. By subdividing work these "green hands" could in a time shorter than under craft apprenticeship requirements turn out products in which quality was less a consideration than price. In addition to flooding the trade with low wage newcomers, masters cut the customary wages of skilled journeymen. Masters who did not do these things failed to sell to wholesalers and they, themselves, frequently were reduced to the journeyman status.

Growth of Unions to Resist.—Desperate craftsmen associated themselves together and demanded that masters pay the usual wages, maintain the apprentice system and stop employing "green hands." Failing to comply, masters faced strikes. The unions calling strikes existed only for the duration of the strike.

A few years previous to these American strikes British workers had faced a similar situation when factories were inaugurated. Failing of redress from Parliament, to which the British craftsmen appealed, they organized unions and struck against employers. The employers haled the men before British courts and convicted the strikers by invoking an ancient common law precedent that had adjudged combinations of workers as conspiracies. In 1799 the employers strengthened their position by a Parliamentary enactment called the "Combination Act," which specifically declared combinations of workers for whatever purposes to be conspiracies. This act was in force in Britain until repealed in 1824.

Conspiracy Cases.—Taking a leaf from the British book, American masters, upon encountering the strike, brought the

workers to trial upon the ground that their unions being combinations were conspiracies in English common law. These trials raised two questions. Did English common law apply in America after our independence? If so, were unions combinations coming under the conspiracy definitions? The first question was vital to our judicial system and also became a contemporary political issue. Upon this the American judges decided that our political ancestry justified our heritage of the English common law. The reply to the second question was not so clear cut, but did seem to say that unions, by the mere association of workers, were conspiracies under the common law.

The doctrine of conspiracy has pursued American unions down to the present day. It has been modified by the judicial declaration that mere association did not constitute the illegality but the intent or purpose of the unions' strike determined the legal status of the strike. When improvement of wages was declared to be a legal purpose of strikes suits were brought on the grounds that the means employed to win a strike were illegal and hence the strike itself unlawful. Confusion on these issues of purpose and means in strikes has not been clarified by the courts. So modern union strikes, just like the earliest ones among city craftsmen, may make the strikers liable to punishment for using an illegal weapon against employers.

Labor Political Parties.—In England after the repeal of the Combination Act in 1824, the great labor program was the appeal for manhood suffrage. American history differs on this point for our workers never had to struggle to secure the vote. Liberty and equality were potent slogans in America during the opening years of the 19th century. Notwithstanding that the framers of our government expected suffrage to be qualified by property provisions, the rampant individualism of the pioneers joined with the sweep of Jeffersonian and Jacksonian democracy to establish manhood suffrage at an early date.

American workers, the first in the world to gain the vote, eagerly turned to politics to demolish special privilege and to exalt the rights of men as men. For these purposes the workers endeavored to get regular political party leaders to espouse the pro-

grams of labor, and when this effort failed the workers formed political parties of their own, nominating candidates from their own ranks.

The programs advanced by the labor group were the movement for public schools—that workers' children could be educated so as to vote intelligently when citizens; the shortening of the work-day to 10 hours—so that workers would have leisure to study public questions and, as a result, vote by reason rather than by impulse; the abolition of imprisonment for debt which bore more heavily upon workers than upon privileged classes; and the abolition of compulsory military training. In the field of finance the workers asked for a reform in banking, the preference of laborers among creditors of a bankrupt, and the freeing from attachment of the trade tools of a worker and a minimum of other property or assets.

Although workers eventually secured all these boons they did not get them through their own separate political parties. In the thirties, when labor political parties first appeared, and at intervals in later decades, separate labor political parties always have failed. This has been due to dissension within the parties, inexperience in political art, slander heaped upon them by opponents and the espousal by other parties of measures first proposed by the labor party that gained popular support. Labor parties often have had temporary success in local elections, and frequently the boost given measures by labor parties has advertised those measures so that they were necessarily adopted by regular parties and eventually enacted into law.

A. F. of L. Political Policy.—The bitter lesson of this early experience caused the American Federation of Labor from its start in the eighties to adopt a non-partisan policy. Always it has "voted for its friends and against its enemies," regardless of party designation. The Federation draws up a platform, submits it to all parties, and supports the one that includes within its own platform those matters most vital to labor. Upon this basis of choice the Democratic Party in national politics most frequently has won official endorsement from the Federation. The state and city federations pursue the same policy for state and local elec-

tions. Candidates, too, are asked for pledges to support labor measures and according to their replies are listed as "friends" or "enemies." The federations have maintained strong active lobbies at Washington and state capitals, to foster desired labor legislation or defeat bills to which labor objected. Moreover, a close record of the votes in legislative halls has been kept by the Federation.

These methods have been satisfactory to the Federation, for it points with pride to a massive collection of legislation favorable to its aims. This may be an unwarranted or exaggerated assumption on the part of the Federation, but its policy is satisfactory to itself.

British Analogy.—In view of the success of the British Labor Party in capturing the government in the backwash of the World War, it may be asked if American labor also will turn to a separate labor party. It is true that American labor history has followed closely that of the British, but as regards politics the analogy is imperfect. Britain is more completely urban and industrial than America, and unions are strongest in the industries and trades of cities. If all American city workers were unionized and supported a party of their own, their numbers would be insufficient to elect a national government. The British unions and labor political party are not limited to actual workers but accept into membership those who espouse their programs. American unions strictly debar from membership everyone not a worker in the trade. Moreover, in Britain unions have embraced the unskilled, whereas in America the skilled only have formed strong unions. The British social organization intensifies class consciousness and so makes a labor party feasible. America has no well-defined social castes and our workers have little class consciousness. Parliament may legislate for the nation but Congress has less power to pass labor legislation than the states, so that in America the success of a national labor party would be of less consequence than in Britain. In addition, American Congressional legislation is subject to review by the Supreme Court. Hence, America is not likely soon to have a government elected into office by the vote of a labor party.

American Socialism.—Upon the continent of Europe the political wing of organized labor is the Socialist Party. In America socialists have been active for more than a half century, and from time to time have tried to capture organized labor or to combine with it. They never have succeeded in this. The socialists themselves have exemplified all the faults and failings of the early American labor political parties and, therefore, have been unable to make strong appeal to organized labor. The latter are no more likely to fall in line with a socialist political party than they are to form a labor party of the British type. To the reasons cited may be added that there is no widespread common grievance among American workmen that would incline them to lend a willing ear to the socialists' doctrines. On the other hand, a great many American workmen have been socialists or have held views that tend strongly toward socialism.

Labor and Social Reform.—While American labor's first interest was in politics, its second enthusiasm was for social reform. The panic of 1837 caused industrial wreckage whose debris was not cleared for a decade. Workers experienced in full the calamity of unemployment or part-time jobs. Anxious to work but finding little to do, labor came to the conclusion that there were some serious defects in the social organization under which they lived. They deemed a society wrong which offered scant occupation to men ready and eager to support themselves and families. Children crying because of pinched stomachs, and wives withering with want, drive fathers to desperate expedients. Radicalism breeds in discontent. The suffering workers of the forties, therefore, listened attentively to proposals promising a better social structure with improved economic opportunity.

Free Land.—Borrowing from popular conceptions concerning human "rights," labor set forth this argument. "Since man is, he has the right to be. Because he has the right to be, he has rights to the requisites to continue being. Among these requisites is land. The conclusion is that labor has a right to land." The labor orators of the forties asserted the right to demand that all property be pooled and redistributed, but they pointed out that this

radical step was unnecessary because there was a vast amount of public land. What was demanded, therefore, was a change in the public land policy, whereby men could secure title to land by living on it and using it rather than by purchasing it. The federal practice respecting public land was to sell it at a low price, generally about \$1.25 per acre, and at times to encourage sales by liberal terms concerning settlement and time of payment. This did not satisfy labor, for the price, low as it was, constituted a bar to the acquirement of land by workers. They asked that land be given to all who would use it, urging that if every man could obtain land easily there would be no unemployment and no suffering from lack of work.

That this proposal was not unreasonable may be gathered from population statistics. The population per square mile in 1840 was only 9.7. Moreover, the population was concentrated in the east, whereas the public land lay in the west.

Yet the Free Land Movement, or Agrarianism, met determined opposition for a score of years. Eastern landlords fought it because it would lower eastern rents. Employers in the same region disliked it because it would raise wages. Capitalists thought it would impair their investments in the East and create extremely risky investments in the West. Southern slave-owners vehemently denounced it, for it would doom slavery by filling the West with small land holdings, thus stopping the extension of slave plantations to new land, without which outlet slavery by its soil exhaustion could not continue. The West naturally was enthusiastic for a proposal that would settle the West. The solid South, together with interested easterners, killed every Congressional bill that would legalize free land. As a result, it was not until the Civil War removed southern representatives from Congress that the Homestead Act was passed. This act culminated the social reform first agitated twenty years previously by distressed labor.

Communities.—It was apparent to some labor spokesmen of the forties that the free land movement could afford no immediate relief, and, therefore, they supported schemes that promised a new social order at once. Ideal communities, in which altruistic

men could work together and share the proceeds of labor on some more equitable basis than under the competitive capitalistic system, had a particular lure for men groaning under the breakdown of capitalistic production. Indeed, this variety of idealism had ancient honorable support. Plato, Sir Thomas More, Francis Bacon, Rousseau and many others had dreamed of ideal communities.

In America both Jamestown and Plymouth for a short period operated as communistic experiments. Before the Revolution the Shakers had set up communities in New York, New England, and in Georgia, while Pennsylvania offered many examples of such communities, of which we need but mention the Moravian, the Mennonite and Dunkard. There was also Joseph Smith's Mormon gathering in Vermont, and Noyes' Oneida community, fathered in New Hampshire but reared in New York and Connecticut. Robert Owen's New Harmony also should not be overlooked. So the community idea was not originated by the social reformers of 1840; rather they furbished an idea that for ages had lain near men's hearts.

The particular type of community advanced in the forties was that proposed by the first modern sociologist, a Frenchman named François Fourier. An American reformer, Arthur Brisbane, travelling in France, became enamoured of Fourierism at the time it was dying in its native land. He brought to America Fourier's books, translated them, and enlisted the support of Horace Greeley in giving publicity to Fourierism. Experimental communities were started at Red Bank, New Jersey; Ripon, Wisconsin, and many other places.

The story of these communities repeats the history of all that have been tried. They began with high hopes and enthusiasm, attracted all kinds of malcontents—soon developed cliques and other internal dissension, and seized upon some natural disaster such as fire or flood to excuse abandonment or remodelling upon familiar private property, capitalistic competitive lines. No community whose tie was economic has succeeded at any time in America. Only those communities whose bond was principally religious have had any length of life.

Cooperation.—A third program of social reform acclaimed in the forties was that of cooperative enterprises. This, too, was not a new venture for labor, for there never has been a time since 1800 when American labor has not in some degree in some place espoused cooperation. The business depression of the early forties emphasized this ever latent desire for a better organization hoped through cooperation. Many times since when labor has been defeated in other attacks, or has felt the closing pincers of a business slump, cooperative enterprises have been attractive to labor.

The scores of cooperative enterprises started during the forties functioned briefly and disappeared. Producers' cooperation then and at all times has generally failed in America for two diverse reasons. Either the original cooperators wisely deferred to some one member whose business acumen rendered the enterprise so profitable that the original members refused to include new workmen as cooperators, and so gradually converted the business into a regular joint-stock association, or else the original members, by mutual jealousy, refused to submit to dictation from any one member, and lacking knowledge of business technique, soon ran the enterprise into bankruptcy. As purely cooperative ventures, both types failed.

Consumers' cooperation likewise in America has had a sad history. Since it has succeeded brilliantly in some other countries the fate here must have been due to factors peculiarly American. Those mentioned generally as explanatory of the American experience are the lack of homogeneity among American workers, and the disdain of Americans for small savings. There is hardly any American working class community with one dominant racial inheritance or with common tastes, preferences and prejudices. Nor are Americans penny pinchers. We will not inconvenience ourselves for the sake of saving a cent or two. A cooperative store does not function easily when it has to cater to a diversity of standards, nor will folks with different standards readily associate together for a common aim. Cooperative stores also can have at best no wide margin over ordinary stores, and their gains result often from inconveniencing their patron-owners, by the location of the store or its lack of special services. These

factors have so limited American cooperative stores that they have had difficulty in securing trained managers. When the managers have been efficient they often have been dishonest, while honest managers all too frequently have been utterly without business knowledge. Of late years, cooperative stores have had to meet the competition of chain-stores. Those who want to save at some personal inconvenience patronize chain-stores, where the saving is immediate and visible. Cooperators have to wait for quarterly dividends to realize the savings on their sacrifices of personal comfort. The buying power of chain-stores enables them to set prices that make savings greater than most separate cooperative stores could grant, even if they were excellently managed. Sometimes it is said that American cooperative stores have failed because they have lacked capital. Rather it should be said that they have not attracted capital because they have so often failed as businesses.

Cooperative credit associations have been a distinct success in America. Building and loan societies belong in this class. By pooling small savings, and making loans on easy terms to members whose financial standing would debar them from accommodation at ordinary banks, these cooperative credit groups have performed a real service. They have occupied a niche in our financial organization which, for a long time, had no other claimant.

Labor and Economic Pressure.—Dissatisfied labor may seek to improve its condition by using the ballot to effect reform; it may join movements to change the order of society so that labor may get a better position; or it may combine and work its will by exerting economic pressure upon employers or society. That is, labor has three weapons: politics, social reform and economic pressure. In America labor tried the first two before it went over wholeheartedly to the third. But even then it reverted to the other two when the business cycle curving downward toward depression made labor's economic power ineffective.

Labor has exerted its economic pressure through unions. City trades, such as printers, carpenters, and shoemakers, were the earliest to organize. These unions were temporary for a specific purpose, and out of their strikes grew the conspiracy cases. The

spread of factories after 1830, with consequent enlargement of towns, produced local craft unions in many places, but the city trade unions continued to be the most active. In order to bring all their strength to bear and to prevent overlapping, the various craft unions in several cities federated. Occasionally the city federations from a group of cities convened together, but usually labor issues did not pass city boundaries. However, a demand like that for a 10-hour day might arise simultaneously in two or three cities. As business approached national proportions, this local organization of labor showed itself unable to cope with the problems raised. To effect a national labor unity there were labor congresses held in the fifties. Since the delegates to these conventions were drawn from various local craft unions and city trades' unions there was no common bond cementing the congresses; they inevitably considered measures of general social reform rather than specific economic issues. Hence, in a few instances, local unions in one trade joined themselves together and by a representative convention instituted national unions in those trades.

Growth of Unions.—The Civil War period accelerated labor organization. The withdrawal of men for the army created labor scarcity and gave power to labor. At the same time business expanded under the heady stimulant of war contracts and thus added to the demand for and the strategic strength of labor. The sharp climb of prices due to the war produced labor grievances. As a result the number of trades organized in unions increased rapidly. The number of nationals formed in particular trades in the same period experienced an unprecedented increase. Coincident with this growth, organized labor became articulate through a paper, *Fincher's Trade Review*, devoted exclusively to trade union and labor interests. Fincher, the editor of this paper and a union officer, together with William H. Sylvis, head of the Iron Moulders' Union, gave a national leadership to the labor movement.

At the close of the war there were several attempts to federate the existing national unions, two of the most notable being the National Labor Union (1866-1872) and the Sovereigns of In-

dustry, the latter an industrial branch of the Patrons of Husbandry (the "Grange"). These efforts failed because the federations drifted into measures and policies of social reform or politics. The business depression of the 70's also caught and crushed them.

The Knights of Labor.—Although none of the federations succeeded, labor organization rose to national prominence through the meteoric ascendancy of the Knights of Labor, a new union founded in 1869 by a tailor, Uriah Stephens, at Philadelphia.

The Knights of Labor was not organized on trade lines, but admitted to membership any man or woman, white or colored, who had an interest in labor. Membership was denied only to liquor dealers, lawyers, bankers, professional gamblers and stock brokers. The eligible members formed local units and these were joined by districts into District Assemblies. The whole order was united nationally by the National Assembly, a representative convention. For a few years the union was secret and its ritual was markedly akin to well-known fraternal orders. Strong public disapproval of secrecy forced the Knights into the open in 1878, and Stephens, too feeble to continue the presidency—he was then 57 years of age and died four years later—gave over the leading office to Terence V. Powderly. Under his vigorous sway the Knights grew startlingly. Individuals, unattached locals of various crafts, trade union locals and nationals applied for membership. Before the nation was aware of it, there appeared in America the largest, strongest labor organization in the world. This union for the first time contested issues with nationally organized business, and at first won its battles. The prestige of these victories brought literally uncounted new members to its banners.

Although the Knights fought and won strikes, its leaders did not favor strikes, but rather depended upon the slower method of education and advocated a social reorganization in which workers would supplant capital through cooperative enterprises. Because it was a labor, not a craft organization, the Knights would not and could not seek particular economic benefits for specific trades.

The American Federation of Labor.—As a result, a few leading trade unionists in 1881 invited trade locals and nationals to form a new organization in which immediate economic trade benefits were to be paramount. This was called the Federation of Organized Trade and Labor Unions of United States and Canada. There was no overt antagonism between this upstart trade society and the Knights. Indeed, a great many individuals and several locals and nationals were affiliated with both. But the leaders of the two were not sympathetic personally nor did they agree on policies and methods. So little by little the two organizations came in conflict. By 1886 the many small irritations and disagreements were fanned into a larger hostility by the attempt of each to absorb the local organizations of the other. In 1886 all appearance of friendliness was abandoned because of incidents connected with a cigar trade dispute in New York. The federation of trade unions reorganized under the name American Federation of Labor and opened war upon the Knights.

The latter had suffered from several unsuccessful strikes and from unwise actions of its chief executives. The trade union membership of the Knights, forced to choose between it and the A. F. of L., cast their lot with the A. F. of L. Since this membership was the backbone of the Knights, the rough severance brought the Knights to collapse. By 1890 it was a flabby relic, and, although it has continued as an organization, it has had no significance in labor matters for more than a quarter of a century.

The A. F. of L., on the contrary, with an astute leadership and an opportunistic policy of grasping what was available, has forged steadily ahead. Though bitterly assailed, it has withstood all shocks. It is the acknowledged power in the trade union movement of the United States.

Other Unions.—Yet, there are several strong unions that have no connection with the American Federation of Labor. Chief among them are the four great railroad unions: the Brotherhood of Locomotive Engineers, the Order of Railway Conductors, the Brotherhood of Firemen and Enginemen, and the Brotherhood of Railway Trainmen. These brotherhoods not only are not united with the A. F. of L., but are independent of

each other. However, they often act together and by community of interest or personal attachment of their leaders, achieve many of the common benefits that would arise from actual federation.

The brotherhoods started as mutual insurance societies. Gradually they added the economic activities of trade unions. In doing so they were for years notably non-belligerent. Negotiation rather than the strike was their policy. But by 1906 the strict regulation of railroads made it difficult for railroad executives to grant trainmen's demands and pass on the load to shippers. Stiffened resistance of executives reacted upon the brotherhoods to make them more aggressive and threatening. How far they inclined toward radicalism was indicated in 1916, when they forced the Adamson Act out of Congress and again immediately afterward when they espoused the "Plumb Plan," which was an adaptation to American railways of the British program of guild socialism. Habits of conservatism, however, are hard to break. The brotherhoods have not indulged in strikes and have entered the highly conservative profession of banking. Moreover, through its bank, the Brotherhood of Locomotive Engineers became owner of a coal mine and refused to operate it on the closed shop union basis.

Another stalwart union outside the A. F. of L. is the Amalgamated Clothing Workers, an organization that enrolls about 85% of all the workers engaged in the manufacture of men's clothing. Prior to its inception in 1910 there were several craft unions in this business but these were weak, hindered each other, and were ineffectual in controlling the manifold grievances connected with sweat shops. The A. C. W. wiped out trade lines and organized on an industrial basis, admitting all workers in men's clothing to membership. The union made some progress before the World War but its great opportunity came when the men's clothing industry was swamped with war contracts. During this conflict the A. C. W. secured control of the greatest clothing manufacturing centers, New York and Chicago, and after the Peace of Versailles extended its dominion to Rochester. It has not been so successful in Baltimore and Philadelphia.

Once in power, the Amalgamated strode forward to the posi-

tion of one of the most advanced unions in America. It instituted a system of collective bargaining and arbitration that largely has eliminated strikes. It cooperated with management in setting and maintaining standards of production. It boosted wages and secured the shortest work-week in America. It installed a system of unemployment insurance. In New York and Chicago it established labor banks. For its members it has an extensive educational program, a system of cooperative housing, and even secures special consideration for its members in the purchase of tickets to symphony concerts.

The Amalgamated Clothing Workers has been called a radical union because its original constitution contained declarations favorable to worker ownership of industry. Its leaders say this was a piece of idealism, to attract members among Russian Jews, who were numerous in the clothing industry. It also took the Soviet concession to operate the clothing factories of Russia, but according to the A. C. W. officers, this was a temporary arrangement—it ceased in 1927—to help the clothing workers of Russia, many of whom were related to or bound by religious ties to the clothing workers in America.

The I. W. W.—A really radical union is the Industrial Workers of the World. When the Knights of Labor lapsed into “innocuous desuetude” there was no worker organization which could unite into one body unattached industrial unions, like the Brewery Workers or Western Federation of Miners, and various labor and politico-labor unions. To fill this need, the I. W. W. was created in 1905 by a group of radical leaders headed by William Haywood, Eugene Debs, Trautman, Daniel De Leon, and St. John.

Immediately dissatisfaction arose over the incumbent of the presidency and the organization’s policy toward political action. The union split into two, each with the same name, one having headquarters in Chicago, the other in Detroit. The latter branch lagged for a dozen years, changed its name, and then succumbed. The Chicago branch lost the support of the Western Federation of Miners, who joined the United Mine Workers and thus affiliated with A. F. of L. The Brewery Workers also was chartered

by the great trades federation. Within the I. W. W. disputes continued over policies until all of its originators withdrew. The remaining nucleus went after a common labor membership, appealing everywhere to exploited workers in this class. For a while the organization appalled eastern conservatives by savage strikes at Lawrence and Paterson. The failure of these strikes caused the I. W. W. to lose prestige in the East and to depend for membership on the casual laborers of the West, among whom it still has a small but influential following.

As it finally crystallized, the policy of the I. W. W. was that of revolution against capitalism, not through politics nor half-way dalliance with economic improvement, but through complete overthrow by direct action. The ultimate object was worker ownership and control of all industry. There was to be no government save that worked out by the workers in each industry for that industry. The industrial unions in each industry were to be international-world-wide.

The methods approved to gain these ends were the general strike and sabotage, followed if necessary by armed force. The policies and methods had a strong appeal to those workers who had no security of jobs, no special skill by which to exact fair bargains, no homes, and no citizenship. Many of them were cruelly exploited by their employers. Finding that the existing order of society gave their wrongs scant heed and grudging relief, such workers eagerly espoused an organization which promised a new social structure in which the commonest labor would rule instead of being ground under heel.

Although the I. W. W. has but a few thousand members in good standing, there are many more who have held red cards and who sympathize with its purposes; in an emergency they would support it. But the organization has the fatal weaknesses of all that have ever sought to unite a rabble; it lacks unity, cohesion, persistence and definiteness.

Weapons of Organized Labor.—American worker organizations have had a choice of several weapons. Two of these, politics and social reform, they tried early in our history and found them ineffective. The third most powerful weapon is economic

pressure. This may be applied by strikes or boycotts. The principal issues in strikes have been wages, hours, working conditions and union recognition (collective bargaining). While strikes seemingly have decreased in total number they apparently are increasing in length of time, numbers of workers and enterprises involved, and in violence. This situation is due to the fact that we have fewer but larger and more powerful unions, organized over greater geographic areas and including greater numbers of unskilled or semi-skilled workers. While much is said about the financial losses of strikes, the workers who strike claim that because many industries are seasonal the time would be lost anyhow, that the per capita loss of wages on account of strikes is less than the loss due to sickness, and that if the strike is won, all losses are soon recovered. Statistically, it would appear that about half of all strikes fail. Unionists claim that such a statement is misleading because strikes often are battles in a campaign and that if the latter is won the loss of battles does not count. Strikes, too, may be merely training schools for successful strikes of larger scope later on. At any rate, the strike is the favorite weapon of labor.

Boycotts a generation ago were numerous and popular among worker organizations. But the decision in the Danbury Hatters Case, which declared that that particular boycott restricted interstate commerce and so was punishable under the Sherman Act, made unions reluctant to try boycotts. The Clayton Act promised to remove this inhibition of boycotts but the Supreme Court decision in the Duplex Printing Company case nullified the exemption of the Clayton Act so far as secondary boycotts were concerned. The risk of prosecution, therefore, is great when boycotts are used by unions. Moreover, boycotts are hard to manage; it is difficult to start one and harder to stop it. The public, which often supports labor's side in a strike, is cold toward boycotts because they have the odor of maliciousness. Labor without public support can seldom conquer.

Evaluation of Unionism.—A test of unionism is to measure its accomplishments against its aims. One avowed ambition of unions is to enroll all workers as members. There were some

forty million wage-earners in the United States in 1927, while union membership was about four million. Hasty deduction, therefore, would assert that unionism was weak. A closer inspection of the components of the forty million wage-earners shows that it comprised many millions in occupations that were unorganizable, such as domestic service, agriculture, and public service. Making allowances for occupations of these kinds, it would be found that the unions had organized over 20% of all workers in organizable trades. Of course, in certain trades the unions had enrolled many more than 20%; for example, 37% of all workers engaged in transportation, and 42% of all miners were unionists. Considering the brevity of time of union organization in the United States, it is evident that unions have gone a long way toward their first aim.

Not only to include all wage-earners in unions, but to hold the gains of prosperity in times of depression has been the aim of labor leaders. Before the American Federation of Labor was formed, union membership and success in bargaining varied directly with business conditions; triumphant with good times, reduced in bad. Partly by a policy of high dues with consequent high benefits, the unions composing the Federation have been able to modify previous experience. The depression of 1893 was weathered, the panic of 1897 was not only passed through without ultra-serious loss of membership and prestige, but some unions were able to prevent undue wage-slashing or wholesale discharges. The aftermath of war, felt in business in 1921, saw the unions militant, defying a loss of war-won wage rates. One of the largest unions, the United Mine Workers, succeeded in keeping the war wage intact, while many unions prevented serious cuts. As with wages, so with other union privileges such as regulation of hours, or collective bargaining. The organizations are now powerful enough to prevent employers, in periods of business slough, from cutting away deeply the advances made by unions when business is climbing the peaks. To the degree that unions have done this and from their point of view, they must be credited with success.

A third way of gauging the success of unionism is by ascertaining how much they have improved working conditions. A

great deal has been done by direct union pressure upon employers, but the greatest achievements in raising working standards have come through legislation. To be sure, the unions alone and unaided have not been responsible for all the laws that have aided labor, for many other groups have been sponsors equally of these efforts, but the unions have been the most insistent and persistent advocates of measures that would ameliorate the condition of workers.

The legislation that has been secured is too diverse and too great in aggregate to be listed, but some suggestion of the whole may be obtained from mention of the laws limiting the hours of work, setting minimum wages, compelling safeguards against injury or disease, establishing employers' liability and organizing workmen's compensation in cases of accident, sickness or death.

CHAPTER XXIV

LABOR'S INDUSTRIAL PROBLEMS

Introduction.—The principal problems of labor have been brought about by the Industrial Revolution, although some emerged during the domestic system. In ancient and medieval times labor's place in society was fixed. As a slave, a serf, or a craft guildsman, a worker's job was assured, his compensation determined both by custom and law, his own movements and those of possible competitors were limited, and whatever rights he possessed guaranteed. Disputes on the manor were settled in the manorial courts, and disagreements among craftsmen were adjudicated by the guild. While the systems of production were not prolific in accidents, and occupational diseases, the workers, being wards, were cared for by the employers' organizations—manor and guild. Likewise, old age was secured against want. The contingencies not provided against were famine, pestilence and war.

The factory system raised the status of the worker to that of a free agent contracting individually for a job, and permitted unobstructed movement. But the hazards of labor were multiplied. No man was secure in his job or provided for in old age, and power machinery introduced numerous risks to life, limbs and health. The separation of the producer from the consumer created periods of boom and of depression, both of which were harmful to the worker; for, in one he was pushed to excessive exertion and in the other was liable to be deprived of all employment. The laborer had no rights which the employer was bound to recognize, so that for a time, at least, the lot of a laborer was worse in his superior status as a free man than it had been when his status was that of a guildsman, serf, or slave.

Getting a Job: Informal Methods.—Labor's most acute problem after the Industrial Revolution was to get a job. The mental

anguish of joblessness must be experienced to be appreciated. Men anxious to work but denied employment are bitter critics of the social order produced by industrialism. Yet this foremost need of labor for remunerative employment has been but little relieved by organized methods of hiring. Most of our industrial pursuits have been recruited by informal methods. A common practice has been the posting of a notice at the gate of the enterprise, and then a hurried superficial selection made by a busy foreman from among the applicants huddled at the entrance. Another method has been for the foreman to tell existing employes of the need for more workers and depend upon these wage-earners to bring in relatives or friends. A brief item in the newspapers often has been the only notice given prospective workers of the existence of an opening. At times when the local labor reserve was exhausted, employers have sent recruiting agents into distant fields to hire workers.

All of these hit-or-miss methods have kept the labor market disorganized, and have debarred the employer from selecting the proper man to fill a place.

Getting a Job: Formal Methods.—To remove the errors in the informal methods of employment, the workers, employers and the government have each striven to introduce more formal procedure.

Unions have set up employment offices at their headquarters, to which members out of work came to learn opportunities. Certain strong unions have insisted that employers hire all men through the union offices. By exchange of information the union employment offices can direct members to the communities where jobs are most plentiful. An employer forced to secure all his force from a union is denied selection of men best equipped to handle the work.

Some advanced employers have taken hiring away from foremen and centralized it in an employment department. This office not only has been open to applicants at all times but on its own initiative has got in contact with sources of labor supply. The most modern of the employment departments submit recruits to tests to determine what they are best able to do, and having made

also a detailed analysis of each job, fit the men to the tasks. Some of the departments have devised formal introductions to the positions so that new men are eased into a plant.

Cities, states and the federal government during the World War installed employment offices. With a few exceptions, the city and state offices have not been favored either by the workers or employers. As the location has been too often either inconvenient or degrading, and the management was put in the hands of inexperienced, unsympathetic, political "lame ducks," both job seekers and employers have tended to shun the public offices, save as a last resort. Hence the best jobs and highest grades of workers have not been listed as a rule in the public bureaus. The federal offices had too brief a life to be evaluated, but many friends of labor hailed them as the solution of the organization of the labor market on a national scale. They were closed by the failure of Congress to appropriate funds for their support.

Private employment offices have been prevalent. Many of them were honestly conducted and performed a valuable function. But inasmuch as they were operated for profit, without public supervision, they lent themselves to suspicion as to their integrity, and some were discovered in scandalous practices.

Unemployment.—If to possess a job was labor's first effort, to be deprived of it for no fault of the worker was his greatest calamity. Unemployment has been caused by the instability of the factory system, and the incapacity of some employers.

The waves of depression following upon surges of prosperity have been a marked characteristic of the factory system. Unemployment has accompanied depression. While this fluctuation of the business cycle has operated over long periods, there have been smaller tides each year due to the regular rotation of the seasons, summer bringing the peak of employment and winter the trough. Within certain industries there has been a seasonal demand related to but not in every case coincident with the normal seasonal cycle. National political upheavals also have been reflected in the demand for labor, a "presidential year" being notorious for the slackening of business.

In special cases employment conditions counter to the general

situation have occurred because of unskilled management or acts of labor organizations.

Some unemployment has been present at all times, even at the height of the greatest boom, but the worst unemployment has happened when all the causes have acted in concert. To workers, the results of unemployment have been catastrophic. They have lost their earnings and savings. If the depression was long drawn out they have lost their skill and finally their morale. The ranks of the casual laborers have been swollen by workers whose character has been undermined by prolonged unemployment. So, also, lack of work has increased crime, and produced habitual malefactors.

The public has sought to relieve unemployment by withholding public work in times of prosperity and getting it done when adversity confronted business. This distribution not only has been economical to governments and avoided pyramiding an already peaked business condition, but has provided necessary work when it was most needed. The Federal Reserve System has done much to mitigate those causes of the business cycle that had been due to inelastic currency and credit. Both public and private organizations have made intensive studies of the business cycle, and by getting at causes or furnishing information of business data have softened the intensity of crises.

Employers of their own accord and by various advices and compulsions have tried to reduce the seasonal character of business. This has been accomplished by inducements to buyers in the "off" seasons, by combining products with different seasonal cycles, by restrictions on the excessive use of "styles," and by using research to control selling policies, methods and markets. Employers, too, that have installed employment departments have offset some of the rigors of a period of unemployment by transferring workers from one division to another instead of discharging those whose present job was of declining necessity. Moreover, enlightened employers have arranged so that the whole force may have partial employment rather than discharging some and keeping others on at full time.

Workers as individuals have solved their unemployment

problem by becoming proficient in at least two trades. Thus, butchers temporarily have become wall-paper hangers, and weavers for a time have worked as chefs. Organized workers have devised two means of meeting depression, one the payment of unemployment benefits, the other an insurance arrangement with employers. In the latter case, a guaranty of a definite number of weeks of work is exacted from the employer. If for any reason the guaranty cannot be met, the workers are paid from a fund contributed jointly by the unions and the employer, or by the employer alone. If the employer provides the fund, it is returned to him if the guaranty of work is fulfilled.

Although all of the solutions of the problem of unemployment have contributed to mitigation of its severity, nevertheless the dread of unemployment remains as labor's worst nightmare.

Immigration.—The workers who hold a job are suspicious of all competitors for it. They looked askance at the immigrants pouring through our carelessly guarded portals. These hordes not only threatened the job but menaced its wages. Labor's price, like that of any commodity, is influenced by the interaction between supply and demand, notwithstanding that labor differs in many respects from other commodities. Unchecked immigration swelled the supply of labor and so tended to depress wages. To be sure, most of the immigrants went into the ranks of the unskilled, but inasmuch as labor has developed a series of differentials in wages to distinguish the value of one job from another, a low rate for basic unskilled labor was reflected through the differentials throughout all the gradations in skill. It was of interest to the highest skilled men to check an oversupply of the least skilled. That 43% of the 34 million immigrants entering America came between 1901 and 1920 gave labor a serious problem in competition, for, in addition to the numbers, the later immigrants sought industrial rather than agricultural pursuits. The favorite goals of the foreign born were the soft coal mines, the steel works, the clothing factories, and the textile mills.

Opposition to free immigration is as old as the nation, but it did not become active until the thirties and forties, when Ireland and Germany sent us so many of their sons and daughters. But

the hostility evaporated in the heat of politics. Until 1876 legislation limiting immigration was left to the states, but in that year the Supreme Court declared the state measures unconstitutional.

Thereupon, Congress, in a wary manner, began to hedge the privilege of free entry. At first only the most obviously undesirable aliens were excluded, such as the imbecile, immoral, criminal and diseased. In 1885 Congress gained courage to debar the importation of contract labor. Agitation for the rejection of Chinese labor was begun as a local issue on the Pacific Coast, an Irish sand lot orator being the first leader against this class. The issue became national for worker organizations when eastern employers used coolies as strike breakers. A first step had been taken by the Burlingame treaty of 1868, which denied naturalization to Chinese. In 1880 a treaty with China permitted regulation of Chinese immigration, and in 1882 Congress suspended all Chinese labor immigration for ten years, a policy made permanent in 1894. Similar opposition to Japanese and Korean labor led to an agreement with Japan in 1907 by which that nation refused passports to her citizen workers intending to come to the United States. In 1907, also, a clause was tucked into a federal immigration law, providing that the President might refuse admittance to aliens whose presence would be inimical to American standards. This was one of several devices to relieve our workmen from competition at home with Orientals.

Continued accumulative pressure upon Congress to go further in narrowing our gates resulted in bills that applied a literacy test to immigrants, but three times these bills met a presidential veto. The third one, that of President Wilson in 1916, was overridden by a two-thirds Congressional vote. Finally, the experience of the World War, which demonstrated that we were not absorbing our alien members as rapidly as we supposed, and the fear of an inordinate flood of people from Europe as a war aftermath, led in 1921 to the first of the "quota laws." Under this and a subsequent law of 1926, immigrants of one nationality are restricted to a percentage of the persons of such nationality already resident in the United States.

Labor Effects of Quota Laws.—The quota laws were pleasing to labor leaders, for the acts had an effect for which the leaders long had been fighting. The domestic labor market was preserved to American labor with a consequent buttressing of the wages, hours and working conditions won by American labor.

Yet there were effects not foreseen. One was the fuller utilization of machinery to do the tasks formerly allotted to unskilled labor. Another was a draft upon female labor reserves to fill the gap left by declining immigration. Again, the laws not being applicable to our nearest neighbors, there was an influx of Mexicans in the Southwest, and Canadians in the Northeast and North. The fourth and perhaps most important result was the shifting of the negro population from the South to northern industrial and mining centers. This movement of colored people has brought in its train serious social and economic problems, both in the negroes' former homes and in their new ones.

Child Labor.—Just as American labor has sought to lessen the competition from immigrant workers, so too it has vigorously fought the employment of children. Child labor has been alarming to adult workers because the low money wage paid has threatened to oust grown men who could not live on the earnings their subsidized juvenile competitors accepted. In combating child labor this economic factor, which has been really the core of labor's hostility, has been hidden because it was too selfish to carry weight. Hence, the publicly avowed grounds for the restriction of child labor have been those of morality, health, and the "future of the state." Undeniably many, perhaps most, of the opponents of child labor have been sincere in bringing to the front the moral, ethical and health arguments against the system.

Under our system of government, restriction of child labor has been left wholly to the states. Every attempt to twist the provisions of the federal constitution so as to prohibit child labor nationally has foundered upon unconstitutionality. All of the states without exception have legislated so as to inhibit child labor. Some of this legislation has been indirect in that it has set up educational requirements so that very young children were too

occupied in attendance at school to accept remunerative jobs. A semi-indirect limitation has been by laws setting hours of work for minors or a minimum wage for them, that were impracticable and unprofitable for industry. Direct curb was put upon child labor by raising the age limit at which it was lawful to hire children. Dangerous occupations, such as mining or quarrying, unhealthful tasks that obviously retarded or threatened development, and jobs that incurred a moral hazard have been prohibited to children. Night work also has been closed to them.

While it is by no means true that this state legislation concerning child labor has been at the behest of adult workers or organized labor, it is a fact that labor spokesmen have been among the most vigorous supporters of such measures. It is also worth noting that their advocacy has not been entirely without self-interest.

Women Workers.—The attitude of men toward women in industry has been much the same as toward children, and for the same reason. The wages of women have been less than those paid to men for the same work. From the same mixed motives men have supported legislation that prohibited women from night work and from certain trades. Moreover, where a union card was an aid to employment, women have been excluded from unions until their numbers compelled their admission as an alternative to disintegration of the union. But despite masculine effort to keep "women in the home," women have surged into industry in increasing multitudes.

If all the data were at hand it probably would be found that the earliest division of employments was based on sex. But these data would also reveal that what has been considered "women's work" at one period has been deemed beyond their powers at another. A minute combing of the data might substantiate the case that men have steadily invaded woman's sphere, rather than the opposite more general conception that women have taken away the work of men. To make the generalization that any particular task belongs by nature to either sex is unsafe, for people differ as human beings as much as they do as men or women. That is, women in their adaptation to a job vary as much among them-

selves as they do from men, and men show a similar diversity. Perhaps there is no "man's job" which could not be performed by some women.

The problem of "women in industry" that has been brought about by the industrial revolution is in the light of history just one more readjustment of the division of employment between the sexes, a division that never has been fixed and unalterable. Save for the textile industry, and even in that the weaving branch would have to be noted as an exception, the first effect of the introduction of power machinery was to give over to men most of the industrial occupations, including those that formerly had been filled with women. But as a misogynist has remarked, "as brains were put in the machines women became capable of operating them." Because machinery has been perfected in all industries the industrial pursuits opened to women have been extended. Beginning with cotton spinning, women have been employed in every wage-earning occupation listed by the census except 27. They would be found in some of the 27 from which they are barred if it were not for social disapproval, legal, or union restrictions. It is significant that since 1880 the number of gainfully employed women compared with the total of all females over ten years of age has risen from 14% to 21%, an increase that was much more rapid than that of the total of males and females gainfully employed in the total population more than ten years of age.

Women have accepted industrial positions because they or their families needed the income, or for the reason that the work in the home having been carried outside, the women have followed. In the social classes where the wage incentive was lacking, girls as well as boys have prepared themselves for a career. Now that women executives are acceptable, young girls who once would have become ladies of leisure, or entered one of the ill-paid genteel positions, choose instead the exciting remunerative competition with men for places in the administration of business.

A discussion of the matter of women in industry usually boggles over the institution of matrimony. For women to remain in industry it is assumed that the home must be discarded and children sacrificed either by denial of birth or by improper rearing. Also, it is taken for granted that all women prefer marriage

to any other occupation whatsoever. These assumptions overlook the fact that many times in past history matrimony, the home, and child training have had to be adjusted to a changed division of employments between the sexes. No one can assert that the traditional activities of women and the institutions that have supported these occupations cannot in any manner be adapted to women who take industrial positions outside the home. Moreover, it would be difficult to prove that every woman, just because she is a female, wishes to become and is equipped to be a wife and mother. What is certain is that more married women actually are going into or staying in industry, and that mothers whose children are old enough to do without constant care are seeking industrial positions.

Women's wages have been lower than men's for the same work primarily for the reason that the reserve supply of women workers has been greater than that of men. Of the 40 million women and girls over ten years of age, only $8\frac{1}{2}$ millions are gainfully employed. Of course, not all the $31\frac{1}{2}$ million could be considered a reserve labor force; no one knows how many might be so classified. But no such potential reserve presses with its weight upon the male workers of the country.

The potential reserve makes women's bargaining power weak. Moreover, women have been in industry such a relatively short time that they lack skill in wage bargaining. Because of custom, which limits the mobility of young unmarried women, they are less able than men of the same age to leave a community where wages are low for one where the pay is higher.

Other reasons advanced for the low wages of women are that often they are subsidized by male relatives; that generally they have no dependents—a man's wage is a "family wage"; that their cost of living is lower than a man's—they do for themselves much that a man must pay to have done; and that in many cases they are temporarily in industry as a stopgap to matrimony and hence have less ambition to become proficient. All of these reasons can be substantiated by investigation but none of them is fundamental nor universally true. All of them are influenced by the relative novelty of industrial occupations being opened to women.

As yet women have not shown much inclination to improve

their industrial position by unionization. This is due partly to the fact that women usually have been engaged in unskilled occupations, and have not had a long tenure in business; and partly to the individualism that has been a result of the manner in which the generations employed to date have been reared. Women have been taught to compete with each other for a much longer time than they have been trained to act together for a common good. Yet despite their handicaps, the absolute number of women members of trade unions increased by five times between 1910 and 1920. In the same period the relative number of women wage-earners in unions rose from 1.5% to 6.6%, the greatest relative gain being in the manufacturing industries, the chief of which was the manufacture of clothing. It may be inferred that women, given the opportunity, learn the advantages of collective bargaining.

Convict Labor.—The free labor of America always has resented the competition of convicts. The workers have said that it was unfair to market the products of prisons because the labor cost in such places was mere subsistence. That is, convicts were virtual state slaves, and free artisans never have been able to hold their own against slave production.

To minimize the competition free workers have urged that convict-made goods be limited in their distribution to state institutions. Wherever this has been denied, the free labor has asked that commodities emanating from prisons be labelled "convict-made" so that buyers may discriminate in purchases. To justify this appeal it was claimed that prison wares were not carefully manufactured, so that buyers ought to be guarded against faulty products. Labor has petitioned, also, that convict goods be limited in their sale to the state where they are manufactured, so that the restrictions placed upon convict products in one state may not be voided by the marketing therein of prison wares from other states.

Shorter Hours.—Since workers believe that at any given time there is a definite amount of work to be done, they favor policies that spread the work over the greatest possible number

of men. Of course this theory is fallacious but within the visual range of the workers it has had all the appearance of truth.

Among themselves workers have advocated shorter hours because apparently a curtailment of the working day either would spin out the duration of the tasks or cause more men to be employed. These reasons for supporting a shorter working day the workers have not presented in public, for obviously the public would be estranged rather than won by such an argument.

To gain public approval for a shorter work day labor has exploited whatever themes were popular at the moment. In the thirties, when labor was straining to get a 10-hour day, they capitalized the interest then shown in manhood suffrage, by pleading that workers needed leisure to inform themselves upon public issues so that they might vote intelligently. A generation later, when agitation for an 8-hour day began, the workers backed their program by the assertion that more leisure was necessary to offset the strain of speeded machine production. Of late, this health vindication has been augmented by an appeal that fitted our condition of living in an age of surplus instead of an era of deficit, namely, that labor needed leisure to enjoy the fruit of production and that without this leisure labor would spend less and hence there would be a shortage of orders acting as a brake on production.

On the other hand, the opponents of a shortened work period have rationalized their selfish interest in a long day by claiming that a restricted work-day must necessarily result in less production and lower wages. In addition, it was said that to give workers more leisure would only grant them time for greater immorality and other vicious indulgences.

As a matter of fact, there is no standard work period that fits all industries equally well. Tasks in which the efforts of the workers most influence output may gain in production rather than lose by a reduction in working time. On the contrary, where the pace of machinery sets the limits of production, output is almost directly in proportion to the time the machines run. However, improved technology may vitiate the first of these cases, and in the second the productivity of machines operating for a shorter time may supply all the public's needs. Industrial prog-

ress makes any standard of working time a flexible matter subject to change to meet varied conditions. Since progress is uneven among industries different work periods may be justified economically, but social welfare should be given full weight before a final determination of the hours of labor.

Historically, the hours of work have been reduced from 12 or more to 8. When the industrial revolution started in America, factory hours were the same as those in agriculture, namely, from sunrise to sunset. In farming these hours were mitigated because the work was variable, intermittent and out of doors. It was realized that the monotonous, constant indoor work of a factory called for different standards. The first great demand for a shorter day was for one of 10 hours. Begun among the building trades in the thirties, the 10-hour day was generally accepted in most mechanical pursuits by the close of the next decade, except for public works and the textile industry. In the sixties, with the rise of the Knights of Labor, the 8-hour day was broached, and after the American Federation of Labor was organized in the eighties, this program became one of its cardinal issues. The 8-hour day made faltering advance through the nineties and was still not generally accepted at the opening of the World War. That conflict enlarged the powers of unions so that they could enforce their demands for a shorter day, and the government contracts—without which few enterprises could operate during the war—stipulated that 8 hours should be the standard working time. In 1919 almost half of all wage-earners were operating on an 8-hour schedule, and less than 10% still had the 10-hour day. In 1926 the average hours of work for wage-earners in all industries were between 47.9 and 48.6 hours per week. Meanwhile, some workers had gained a five-day week of 40 to 44 hours.

Under the leadership of the American Federation of Labor the method of gaining the shorter work-day changed. Previously the effort had been to surge all occupations forward at once in one long crest but this was shattered on the united opposition of employers and the public. The A. F. of L. abandoned mass movement in favor of a continuous lapping now against one employer and then against another, crumbling the opposition

where and when it was weakest. That this policy was practical has been shown by results.

Restriction of Output.—The “lump of work” theory has also affected labor’s policy as to output. In putting restriction of output into effect labor has used both direct and indirect means. In some instances a definite measured limit was set to what an employe could produce. In others various working rules have been designed for the same purpose. For example, plumbers returning to a shop for tools were forced to walk, and painters were forbidden to use brushes of more than a certain width, and denied the help of paint sprayers. In printing offices “boiler plate” stuff—already set up—had to be duplicated by typesetters, although their finished job never went into a press.

Piece-rate workers have had the further motive of restricting output because previous experience has taught that excessive earnings gained by unusual exertion have been cancelled by a cut in the rate, the net result being a “speeding up.”

Economically, restrictions of output add to the cost of production and by high prices reduce demand and so lessen the employment of workers. The actual result of the policy is the opposite of the one hoped for by its promulgators.

The Closed Shop.—Both to patent the job and safeguard its wage, some organized workers have demanded that employment be limited to their membership. This action is vindicated on the grounds that it was the organization that obtained the wage rate and working conditions that made the job attractive, and that it would be unfair to let those who shirked the burdens of assault share the benefits of victory. A closed shop can be maintained only by a strong union and one that is careful in the selection of its members.

Those employers who most bitterly have assailed the shop closed by a union have stood for what they have called the “open shop” but in reality one that amounted to another kind of closed shop—one that was closed to union members. These employers have gained a public hearing because the phrase “open shop” appeals to American individuality and equality of opportunity.

It is significant that the employers who most vociferously champion the worker's right to contract as he pleases for his labor are also the most implacable enemies of unions and all their policies.

Many unions and more employers are indifferent to the shop closed by the union. If wages, hours and working conditions are satisfactory to the union they are not insistent that all workers be union members, while the employer whose labor costs are gratifyingly low per unit of output is not disturbed by affiliations his employees may have. Each side lets well enough alone. On the other hand, either variety of closed shop—closed to, or by, a union—is likely to be a challenge provoking the opponent to upset it.

Accident and Industrial Disease.—Next to the risk of losing the job, workers have been troubled by the risk to limb and life that has accompanied machine production.

Under the common law an employer was responsible for providing safe working conditions. But an injured worker who sought recompense at law found that the employer as a rule could escape by pleading one or more of three defenses; first, that a worker knew the risks when hired and by accepting employment assumed the risk; secondly, that the injury was due to the worker's own negligence; and lastly, that the accident, if not caused by the victim's carelessness, was the result of another worker's lack of caution.

When the common law was in process of formulation these defenses were reasonable, for working groups were small, and the circumstances surrounding a job were well known. But under modern industrial conditions a candidate for employment could not know ordinarily the risks involved; if he did, he had no power to change the hazards, or to refuse the job if no other were open. As for being responsible for the acts of fellow workers, that theory was silly in the great modern plants where one man, far removed from another, might do or neglect to do that which caused the second to suffer. Moreover, accidents for which the sufferer was himself to blame were as often the result of ignorance as negligence. Only when gross negligence could

be proved was it reasonable to charge a man with responsibility for his own malady. Despite these reasons, until 1908 workers bore the full brunt of the physical hazards of employment, for few injured men sued their employers, and of those who did, few faced juries who were not bemused by the employer's legal defenses.

In 1908 Congress lifted the load of responsibility for accidents from the shoulders of those working for the federal government, and in 1911 no less than ten states legislated away the employer's defenses. Between that time and 1927 all the states save six gave more or less protection to their workers.

These laws have accomplished two results: first, they have made the employers responsible for all accidents by removing the common law defenses, and secondly, they have provided an orderly scheme of compensation for accidents. The details of the laws have varied over wide limits, and in a single state the laws have been changed from time to time. But in 42 states and the District of Columbia the principles of the laws may be said to be established.

The employers thus made to assume full responsibility have safeguarded dangerous spots in the works, conducted safety campaigns and installed medical services for emergency relief. The financial burden of compensation has in 6 states been borne by monopolistic state insurance; in one by semi-monopolistic state insurance; in 10 by private insurance in competition with state insurance; and in the remainder, the majority, in the absence of state insurance, the employers have been left to select their own method of insurance. In most of the states the administration of the compensation features has been delegated to a state commission or boards or designated officials.

While few, if any, employers would welcome a return to the older system, many have been disturbed by the tendency of legislatures to broaden the scope of the laws in the definition of accidents compensable, the length of the compensable period and the amount paid.

Industrial disease was not originally treated in the compensation laws as a compensable hazard of employment. But gradually those maladies that clearly are due to the work have been

treated in the same manner as accidents. In some jurisdictions the demarcation between industrial and other diseases has been worn so thin that a worker or his family may receive compensation for diseases that have no direct connection with the work.

Old Age.—As a worker advances in years, in addition to his anxiety over his job and its threats to life and limb, there rises the grim specter of the creeping paralysis of age. By no means all workers tremble at the approach of senescence, for some have made financial provision for retirement, while others have relatives among whom silvered heads are honored and cherished. But thousands of aging men and women can hope for nothing better than the impersonal limited relief of public charity. This raises the question: Should industry be responsible for those who reach the Biblical "time of man" while still serving? The affirmative answer is based on the fact that industry has used a man's powers when they were at their height, and so just as provision is made for the retirement of machines, so also industry should care for the human machine that has worn out in delivering work. Employers have been led to make such provision because, by removing the fear of dependence, the morale of the middle age workers is increased. Moreover, costly labor turnover is reduced where length of service is rewarded at its termination by permanent "retired pay." Yet the workers themselves have not so readily assented. They who object have said that the daily wage of younger men should be high enough for them to provide for their own retirement. They resent the hold given an employer by any scheme for paying workers after retirement. They look upon pensions as paternalistic and hence, contrary to American self dependence and fear that the certainty of a pension will breed shiftlessness among the prospective recipients. Some employers also who have investigated pension schemes are given pause when they learn how the costs of such schemes, deceptively low at first, leap upwards with the passage of years. Other employers, foreseeing a time under a pension scheme when a goodly proportion of their workers would be enfeebled, are afraid that the fierce pace of competition could not be met with a withered working force.

Partly as a consequence of the strength of the negative position and partly due to a disregard of any problem concerning aged workers, the majority of industrial enterprises have made no formal provision for the old in service. Instead, each case is cared for as it arises. In some a pension is granted but in most, lighter work is given. This has to be done cautiously so as not to hurt the pride of the old man nor to diminish his earnings. Just as retired corporation presidents are made members of an executive board, so hoary workers are relieved of excessive exertion by appointment to posts requiring mental agility, tact, good fellowship or industrial experience. When we know more about the human mind and body, we may discover that keeping old people at work at useful, necessary tasks is more merciful than shelving them on a pension.

Employers' Solutions: Stock Ownership.—Employers who regard their workers as something more than purchasable commodities have put forward several schemes as solutions of besetting labor problems. Some not so altruistic have espoused the same schemes as antidotes to unionism regarded by them as toxic. A policy popular among many employers is that of making easy the purchase by employes of stock in the company for which they work. The employers think that by giving the labor force a stake in the concern loyalty, permanence, and a satisfaction with conditions will be attained. Some theorists sympathetic to labor have seen in worker ownership of stock an entering wedge by which may be gained a return to the older system of worker control of the tools of production, using for this purpose the selfsame capitalistic organization of machine industry that so frequently has been accused of enslaving labor.

The rose tints with which this scheme has been painted fade when it is known that in the companies where it has been tried a slim minority of workers has been attracted to it and these have been subjected to the virus of watching the stock market. Great shrinkage in stock value has been followed by worker resentment against the company. In realizing the ease with which "insiders" control great corporations, even when owning a minority of stock, the hope is faint that worker stock ownership

may accomplish worker direction of industry even if the existing slim minority of worker investors should swell to a majority. That the employes could themselves become the "insiders" is not probable, for individually they are too ignorant of business finance and collectively in unions their interests are too dispersed. Yet, the ownership of industries by unions offers the best chance for workers to repossess the means of production.

Profit Sharing.—Both altruistic and selfish motives likewise have been behind the employer's schemes of profit sharing.

That profit sharing has been most popular in periods of prosperity when individual workers and unions have exerted their maximum power, or after a strike disastrous to employers, gives to the selfish motive for profit sharing the greater weight. Profit sharing has been most successful when operated by sincerely altruistic employers.

In only one case, the Dennison plant, have workers themselves asked to share in company profits. Since in every other instance the instigation has come from the employers, the workers have suspected hidden traps. The account books of the company not being open to the employes, they have felt that the shares of profits allotted to them have been determined by manipulation to their disadvantage. Workers everywhere in all occupations generally believe that profits are larger than actually is the fact, for the workers know little of indirect costs and reserves.

As a matter of fact, in most industries the efforts of the workers have slight bearing upon the profits, and the larger the business the less can employes see that their actions produce gains or losses. Except for executives, or for workers in small concerns or industries in which the labor cost exceeds all others by a wide margin, profit sharing is based upon a fallacy. The workers feel this, if they do not know it. As a solution of labor problems therefore, profit sharing is usually futile. A prosperous business wishing to divide its earnings between its stockholders and its employes would fare better by increasing wages. This they hesitate to do because the high rate becomes a fixed charge difficult to meet in periods of business depression, and a

wage cut would stir animosity among the workers. To do good is often more difficult than to inflict harm.

Shop Councils.—An employer's movement of much more practical significance than worker stock ownership or profit sharing is the shop council. By representative shop bodies the workers are privileged to debate and sometimes to legislate upon matters directly of interest to the employees. The degree of power and the questions considered by the councils are determined by the management.

Employers have favored councils because they provided a legitimate opportunity for workers to voice grievances, bring them to the attention of the management, and suggest cures. The executives have hoped, also, to arouse the workers' interest in the plant by giving them a share in management, a by-product being more efficient production. Some employers have installed councils because shop representation was deemed an offset to unions.

Labor as a whole has been lukewarm to councils for the reason that they were suspicious of the employer's motives, and feared that active criticism of the management in the council would subject the accuser to harmful discrimination. However, where the employer's sincerity was not questioned, the jurisdiction of the councils wide, and the measure of power considerable, the workers have responded enthusiastically. A few have gone so far as to point an analogy between industrial democracy and political democracy, hailing the council as the opening of a new sphere of freedom.

However, the council is a privilege, not a right, and may be withdrawn upon due notice by option of the employer. The management generally is not bound by any decision of the council although in practice it generally has carried into effect the recommendations of the works committee. The powers of the council, where widest, stop far short of actual management of the business and carry no authority to elect executives. It is possible, of course, that what at first has been a privilege may become enforced, by strike, boycott, or merely by custom as a right, and that the powers will be extended in time so as to give

workers full control of the operation of the business they are in; but the probability of this happening is slight, for the mass of workers neither have any such ambition nor the training and ability to fulfill it.

Employers who have installed councils with the purpose of forestalling unions have been shortsighted. The councils prove excellent schools for collective action, and would provide an admirable nucleus in each plant for an industrial union. The latter by the very nature of their organization are forced to be more radical in their demands, and more vigorous, even violent, in the method to gain ends than craft unions.

Yet despite the limitations of the councils, they have been as valuable to management as any staff department. To the workers the councils have brought much improvement in the things in which they are most interested, namely wages, hours and working conditions.

Agencies of Industrial Peace.—In the past the only method of solving acute disagreements between employers and workers was resort to force. The wastes of industrial warfare have been as frightful as the ravages of military conflicts. In the destruction of property and the sacrifice of lives the two have been much alike. Although the destructive tactics of workers have been more conspicuous, the actions of employers have been no whit less indefensible. Unfortunately, the damage of industrial conflict has not been confined to the combatants, for the innocent public has been hurt as much or more than either party to the disturbances.

Thoughtful persons have endeavored to substitute the rule of reason for the brutish decision by force, and have called upon the public to provide peaceful means of settling industrial controversies.

The trade agreement was the first sane method to rise superior to strikes and lockouts. Trade agreements have occurred, generally after long experience has demonstrated the futility of strikes or lockouts, where the employers and workers were of about equal power. A trade agreement is arrived at by negotia-

tion between employers and workers and it lays down the terms of employment for a definite period. While it resembles a contract it is not enforceable at law because unions are not legal persons. Trade agreements, therefore, are kept only as long as the two parties have equal ability to inflict damage upon the other if the agreement is broken or the method of trade agreements abandoned. The agreement itself may become the source of conflict unless it contains provision for the interpretation of its meaning by a person or group whose decision is binding.

The public, through its legislative representatives, has made provision for mediators, conciliators and arbitrators, upon whom workers or employers could call for aid in settling disputes. Mediators and conciliators have not been distinguished sharply, but both function to bring together the disputants who arrive at any understanding by their own efforts. Arbitrators sit as judges, hearing what each side has to offer as a case, and then the arbitrators hand down a decision. In this country only two states have taken steps to make arbitration compulsory, and only one has tried to impose the arbitrator's decision as binding.

As a rule, in this country neither employers nor workers have been cordial to the official peacemakers. They have been called upon generally by the side that was weaker, or by one or both sides as a gesture of deference to public opinion. Too frequently the officers appointed to the responsible positions of settling industrial disputes have lacked the experience and balance their tasks needed.

Kansas and Colorado Instances.—Kansas went the furthest of all the states in banning strikes and lockouts and in compelling the submission of industrial disputes to a special court. This body was created by a special session of the legislature in 1920, following a bitter strike of coal miners. Starting with widespread hope for its success, this court has been shorn of real power by two adverse decisions of the United States Supreme Court, and by political influences in the state.

Colorado, after the great strike against the Colorado Fuel and Iron Company in 1913, passed, in 1915, a law based upon the Industrial Disputes Act of Canada. While not outlawing strikes and lockouts, this law compelled the interested parties to submit

their cases to arbitrators appointed for the occasion. The decision of the arbitrators was not binding after a given time but full publicity was to be given to the arbitrators' findings. The Colorado Act, like its Canadian predecessor, has had considerable success. Neither has prevented strikes but both have been employed frequently to avoid strikes.

The Federal Government.—The Federal Government provided machinery for the hearing of railroad disputes by arbitrators as early as 1888. Ten years later the Erdman Act provided for mediation and arbitration, but in its life of fourteen years only 12 cases were heard under the rules of the law. The Newlands Act, passed in 1913, broke down under the exigences of the World War and was superseded, at the close of the War, by the Railway Labor Board created in 1920. After a short, stormy career this board was discarded in favor of regional boards of arbitration. This brief survey indicates that the national government has had but slight success in bringing orderly negotiation into just one great industry, but this inference is not entirely warranted. The two interests concerned, workers and railroads, have been unusually powerful, and the problem more than ordinarily intricate. We have been slowly feeling our way to a reasonable workable solution, and public opinion, once but slightly aroused, has become fairly solidified in favor of some equitable method of deciding employment conditions without resorting to disastrous strikes or lockouts.

INDEX

A

- ACCESSORIES,
 - Manufacture of, growth of, localization of industries due to, 129
- ACCIDENTS, INDUSTRIAL, 584
- ADVERTISING, FACTORIES AS AFFECTED BY, 115
- AGRARIANISM, 556
- AGRICULTURE, 3-27 (See also "Crops," "Livestock")
 - Agricultural colleges, 23
 - Agricultural societies, 23
 - Automobile as affecting, 243
 - Automobile outlet in, 239
 - Capital investment, 4
 - Cement industry outlet in, 509
 - Colonial period, 6-13
 - Commerce in relation to, 18
 - Draft animals, 7, 15, 59
 - Education, 23
 - Experimental work, 24
 - Farm journals, 23
 - Farm lumbering, 7, 29
 - Farm system, sources, 4
 - Self-sustaining, 8
 - Federal land policy, 25
 - Labor, 8, 9, 11, 14, 22
 - Large-scale farming, 25
 - Machinery, 20
 - Manufacturing in relation to, 3, 19
 - Market, 3, 19, 112
 - Middle States, 5, 9, 16
 - Middle-West, 162, 174
 - New England, 5, 6-9, 16
 - Post Civil War, 16-20
 - Post-Revolutionary, 13-16
 - Products (See also "Crops," "Livestock"), price, 4
 - Railroads as affecting, 109
 - Regional specialization,
 - Colonial period, 6-13
 - Post Civil War, 16-20
 - Post Revolutionary, 13-16
 - South, 5, 10-13, 16, 85
 - Status, 27
 - Steel outlet in, 162, 174, 205, 206
 - Steel scrap, 193
 - Tools, 20
 - West, 13-16
- ALUMINUM, 123
- AMALGAMATED CLOTHING WORKERS, 564
- AMERICAN FEDERATION OF LABOR, 554, 563
- ANCHORS, 166
- ANIMAL POWER, USE OF, 7, 15, 58, 59
- ANTHRACITE (See "Coal")
- APPLES, GREENING, 9
- ARBITRATION OF LABOR DISPUTES, 590
- ARMAMENT, SHIP, 166
- ARSENALS, UNITED STATES, 173
- ASSUMPTION OF RISK, DOCTRINE, 584
- AUTOMOBILES, 213, 244
 - Advertising, 244
 - Agriculture,
 - As affected by, 243
 - As outlet for, 239
 - Assembly, methods, 230
 - Body design, changes in, 233
 - Closed car, 233
 - Commercial, 225
 - Changes in design, 234
 - Decentralization of industry, 147
 - Design, changes in, 233-236
 - Detroit, 242
 - Early, American, 238
 - Electric, 215, 239
 - Exports, 244
 - Financing, 243
 - Ford Motor Co., 147, 219, 237
 - Gas engine, 215
 - General Motors Corporation, 221
 - Industry, growth, 218
 - Influence, 243
 - Invention, 214
 - Iron industry as affected by, 163
 - "Jitneys," 227
 - Localization of industry, 125, 232, 242
 - Manufacturing as affected by, 244
 - Market, 231, 238-242
 - Mass production, 231, 238
 - Mechanical design, changes in, 234
 - Middle West as greatest outlet, 241
 - Motor bus, 227
 - Oldsmobile, 217
 - Patents
 - Pooling, 238
 - Selden, 237
 - Peddling by, 160
 - Production, 213
 - Races, 232
 - Raw materials, effect on location of industry, 243
 - Shows, 235

AUTOMOBILES—(Continued)

- Standardization of parts, 231, 232, 237
- Steam, 214, 239
- Steel outlet in, 163, 205
- Steel scrap, 193
- Streamline design, 233
- Style element, 236
- Taxicabs, 224
- Testing, 232
- Tractors, 229
- Trailers, 235
- Trucks, 226
- Willys-Overland Co., 222

AXES, 169

B

- BAKERIES, 98
- BANK NOTES, 111
- BANKING,
 - Federal Reserve System, 116
 - National bank system, 116
 - United States banks, 110
 - "Wild cat," post Revolutionary period, 111
- BARBERS, 91
- BARRELS, 93, 167, 258
- BEVERAGES, 88
- BIMETALLISM, 115
- BLACKSMITHS, 91
- BLANKETS, 382
- BOILER, "FLASH," 215
- BOLL WEEVIL, 352
- BOTTLES, 529
 - Machinery, 537-540
- BOUNTIES, CROP, 7, 11, 84
- BOYCOTTS, 533
- BRASS,
 - Decentralization of industry, 143
 - Expansion, 154
 - Family control, 127
 - Localization of industry, 125, 127, 129, 130
 - Rise, 153
 - Waste utilization, 131
- BRICK, 519-522
 - Bricklayers' union, 522
 - Cement industry as affecting, 522
 - Fuel, 520
 - Labor, 520
 - Localization of industry, 520
 - Market, 521
 - Process, 519
 - Raw material, 519
 - Scale of operation, 520
 - Substitutes, 522
- BROOMS, 88
- BRUSHES, 257
- BUILDING,
 - Cement in, 509
 - Steel outlet in, 162
- BUSINESS CYCLE, 572
- BUTTONS, BRASS, 153
- BUYING, LOCALIZED INDUSTRIES, 134
- BUYING POWER, POST-CIVIL WAR PERIOD, 113

C

- CABINS, MANUFACTURING IN, 83, 84
- CALCIUM CARBIDE, 123
- CALICO, 288, 289
- CALIFORNIA,
 - Gold mining, 47, 111
 - Sheep raising, 366, 389
- CANDLES, 89, 257
- CANNED GOODS, BEEF, 265
- CANNERIES, 98, 141
- CANNON,
 - Iron, 166
 - "Swamp Angel," 174
- CAP MAKING, 130
- CAPITAL INVESTMENT,
 - Agriculture, 4
 - Cement, 514
 - Cotton, 299, 304, 312, 318, 343, 344, 354
 - Decentralization of industry as affected by, 144
 - Electric power, 79
 - Factories, 101, 110, 115
 - Glass, 534
 - Localization of industry as affected by, 128
 - Meat, 286
 - Mining, 55
 - Paper, 478, 487
 - Shoes, 455, 462
 - Steel, 195
 - Wool, 392
- CARBO ELECTRIC POWER PLANTS, 76
- CARPENTERS, GUILDS, 549
- CARPETS, 366, 386
- CARTELS, STEEL, 200
- CASHMERE, 384
- CASSIMERE, 383
- CATTLE, (See also "Hides," "Meat")
 - Beef cattle, 260
 - Breed, improvement in, 260
 - Driving, 254, 259
 - Fairs, 255
 - Fattening, 255, 261
 - Hogs vs., 251, 265
 - Imports, 245
 - Market (See "Hides," "Meat")
 - Oxen, 7, 15
 - Ranches, decline, 437
 - Ranges,
 - Colonial, 247
 - Railroads' influence on, 258
 - Slaughtering, 245, 262, 265
 - South, 12, 330
 - "Stockers," 255
 - Texas, 259
- CEMENT, 495-519
 - Binders,
 - Early, 495
 - Gypsum rock, 495
 - Lime, 496
 - Brick industry as affected by, 522
 - Capital investment, 514
 - Consumption, 509
 - Early American, 502
 - European vs. American methods, 503

- CEMENT—(Continued)
 Imports, 501, 509, 517
 Kilns,
 Fuel, 507
 Rotary, 504
 Lehigh Valley, 502, 512
 Localization of industry, 130, 499, 511
 Machinery, crushers, 506
 Market, 501, 509
 Mergers, 514
 Monopoly, 514-517
 Natural, 497-500
 Origin, 495
 Portland cement, 500-519
 Portland Cement Association, 518
 Power requirements, 508
 Price, 508
 Production, 509
 Puzzolan, 496
 Puzzoulana, 495
 "Roman cement," 496
 Standardization, 510
 Waste utilization by, 130
 CHAMMOIS, 428
 CHANCE, LOCALIZATION OF INDUSTRY DUE TO, 126
 CHARCOAL, USE IN IRON FURNACES, 162, 164, 167, 170, 177, 181
 CHILD LABOR,
 Colonial period, 548
 Cotton manufacture, northern, 303, 305
 Opposition to, 576
 CIGARS, 121
 CITIES, AUTOMOBILE AS AFFECTING, 243
 CIVIL WAR (See "Post Civil War Period")
 CLAY,
 Digging, 45, 51
 Industries (See "Brick," "Pottery")
 CLOCKS, 154
 CLOSED SHOP, 583
 CLOTHING,
 Household manufacture, 89, 97
 Ready-made, 97
 CLOVER, 7
 COAL, (See also "Coke")
 Anthracite, use in iron furnaces, 181
 Bituminous, as kiln fuel, 507
 Glass making, 533
 Mining, 45, 47, 49
 Steam power, 67
 Supply, localization of industries due to, 123
 COKE,
 Beehive process, 190, 208
 Best, 209
 By-product oven, 190, 209
 Substitutes, 141
 Use in iron furnaces, 176, 183
 COLONIAL PERIOD,
 Agriculture, 6-13
 Cotton manufacture, 97, 289, 290, 329, 332
 Factory system, 100, 104
 Glass, 527, 529
 Labor, 547-569
 COLONIAL PERIOD—(Continued)
 Leather, 429
 Lumbering, 28
 Mining, 44
 Peddlers, 149
 Wool, 367-371
 COMBS, 155
 COMMERCE,
 In relation to agriculture, 18
 British Colonial policy, 84
 Iron, 166
 Manufacturing, 93
 Mining, 56
 Napoleonic wars, 105
 COMMUNISM, 557
 COMPANY STORE, 305, 354
 COMPETITION,
 Cotton, 313, 327, 348
 Localized industry, disadvantage of, 138
 Lumber, 31, 38
 Steel, 196
 COMPRESSED AIR, AS POWER SOURCE, 80
 CONCENTRATION OF INDUSTRIES (See "Localization of Industries")
 CONCRETE, BRICK INDUSTRY AS AFFECTED BY, 522
 CONTRIBUTORY NEGLIGENCE DOCTRINE, 584
 CONVERTERS, TILTING, 192
 CONVICT LABOR,
 Colonial period, 95, 101
 Opposition to, 580
 COOKING UTENSILS, IRON, 163, 169
 COOPERAGE,
 Iron outlet in, 167
 New England, 93
 Packing as affecting, 258
 COOPERATION,
 Consumer, 559
 Cooperative community labor, 548
 COPPER MINING, 45, 48, 51
 CORN, 11, 15
 CORPORATION, FACTORY AS AFFECTED BY
 RISE, POST CIVIL WAR, 115
 COTTAGES, MANUFACTURING IN, 83
 COTTON,
 Atlanta International Cotton Exposition, 341
 Boll weevil, 352
 British manufacture, 288, 306-308
 Capital investment, 299, 304, 312, 318, 343, 344, 354
 Child labor, northern, 303, 305
 Climate as affecting manufacture, 311, 358
 Colonial manufacture, 289, 290, 329, 332
 Combinations in manufacture, 319
 Company store, northern, 305, 354
 Competition, 313, 327, 348
 Cotton-gin, effect on slavery, 551
 Cotton Manufacturers' Association, 320
 Cotton Textile Institute, 321
 Decentralization of industry, 357
 Electric power mills, 314, 349
 Employee stock ownership in mills, 300, 344
 Family control, 127

COTTON—(Continued)

- Ginning, cotton gin, 290, 331
- Goods,
 - British Colonial policy, 289
 - British legislation against, 288
 - "Buyers' strike," 323
 - Distribution, 317
 - Market, 318
 - Price, 323
 - Production, 359
 - Style factor, 318
- Hours of labor, 325, 356
- Household manufacture, 289, 294, 329, 330, 336, 338, 389
- Imports, Colonial period, 289
- Individual motors in mills, 315, 349
- Internal combustion engines in mills, 317
- Labor,
 - British manufacture, 306
 - Cotton growing, 333
 - Negro, 339, 352
 - Northern manufacture, 302, 305, 306, 324, 357
 - Southern manufacturing, 335, 342, 344, 351-356
- Localization of industry, 123, 127, 128, 129, 297, 313, 357
- Lowell, 296, 298, 299, 304, 312
- Machinery, 125, 289, 291, 301, 306, 317, 349
- Market 318, 346
- Mass production of goods, 302, 313
- Mergers, 319
- Mill buildings, 348
- Monopoly, 317
- Northern manufacture, 288-328
 - Advantages, 357
 - Buildings, 348
 - Capital investment, 299, 304, 312, 318, 354
 - Colonial period, 97, 289, 290
 - Competition, 313, 327, 348
 - Electric power, 314
 - First complete factory, 295
 - Internal combustion engine, 317
 - Labor, 302, 305, 324, 357
 - Localization, 297, 313, 357
 - Lowell, 296, 298, 299, 304, 312
 - Manufacture, associations, 320
 - Mechanical power era, 309-328
 - Monopoly, 317-320
 - Post Revolutionary period, 97, 106, 291-298
 - Providence, 299, 304
 - Seaboard mills, 311
 - Steam power, 290, 309-314
 - Water power, 288-308
- Origin, 288
- Power transmission by electricity in mills, 314
- Products, 346
- Providence, system of processes and practices, 299, 304
- Quality production, 304, 306, 313

COTTON—(Continued)

- Raw Material,
 - Control of production, 317
 - Importation, 294
 - Price, 323
 - Production, 289, 298, 321, 330-335, 340
 - Proximity, 348
 - Sources, 3, 16, 17
 - Supply, 321
 - Western, 361
- Southern manufacture, 329, 356
 - Advantages, 348-356
 - Buildings, 348
 - Capital investment, 343, 344
 - Colonial period, 329, 332
 - Competition, 313, 327, 348
 - Electric power, 349
 - Expansion, 346
 - Growth of factories, 340-343
 - Labor, 335, 342, 344, 351-356
 - Machinery, 349
 - Market, 346
 - Post Civil War period, 338-356
 - Post Revolutionary period, 336
 - Products, 346
 - Southwest, 360
 - Steam power mills, 345, 349
 - Taxes, 350
 - Topography as affecting, 329
 - Water power mills, 332, 336, 338
- Specialization, British, 307
- Spinning,
 - Climate as affecting, 312, 358
 - Early factories, 97, 292, 294, 343
 - Jenny, 290
 - Mule 290, 307
 - Production, 306
 - Southern specialization, 346
 - Water frame, 290, 291
- Status of industry, 328, 361
- Steam power mills,
 - Northern, 290, 309-314
 - Northern manufacture, 288-308
 - Southern, 345, 349
- Substitutes, 361-364
- Wages,
 - Northern manufacture, 304, 324
 - Southern manufacturing, 345, 354
- Waste utilization, 477
- Water power mills, south, 332, 336, 338, 349
- Weaving,
 - Climate as affecting, 312, 358
 - Drop box, 290
 - Early Southern mills, 346
 - Flying shuttle, 290
 - Household, 294
 - Power loom, 290, 296
- Women operatives, 302, 305, 307, 326, 353
- CRAFTSMANSHIP, 90-99 (See also "Factory System," "Household Manufacture")
- Craftsmen's shops,
 - Large scale, 94
 - Producing for sale, 92, 445
 - Supplementing home industries, 90, 370

CRAFTSMANSHIP—(Continued)

- Evolution, 83
- Factory system vs., 98
- Household manufacturing as supplemented by, 90
- Itinerant craftsmen, 90, 370, 447
- Labor, 95, 549, 551
- Survivals, 97
- Village mills, 91
- Wood, 43
- CREAMERIES, 98
- CREDIT SYSTEM, FACTORY AS AFFECTED BY RISE, 116

CROPS,

- Bounties, 7, 11, 84
- Corn, 11, 15, 17
- Cotton, 3, 16, 17
- Flax, 11
- Hay, 7
- Indian's influence on, 6
- Indigo, 12
- New England, 6, 8, 17
- Rice, 12, 16
- South, 10-13, 16, 17, 335
- Tobacco, 8, 10, 11, 16, 17
- Truck and fruit, 17
- Wheat, 15, 17
- Wheat, 6, 13, 17

CUPOLAS, ELECTRIC FURNACE AS AFFECTING, 192

CURRENCY SYSTEM,

- Factories as affected by post Civil War period, 115
- Inflation, post Revolutionary, 111
- Irredeemable paper, Colonial period, 103, 110
- Metallic money, post Revolutionary period, 111
- Paper money, standard national, 116
- Scarcity of currency, Colonial, 102

CUSTOMS DUTIES (See "Tariff")

CUTLERY, 186, 194

D

DAIRY PRODUCTS, 17

DECENTRALIZATION OF INDUSTRY, 140-148

- Automobiles, 147
- Brass, 143
- Canning, 141
- Capital investment as affecting, 144
- Cotton, 357
- Ford cars, 147
- Fuel, as factor, 143
- Furniture, 142
- Glass, 143
- Labor,
 - Advantages to employee, 147
 - Supply, skilled, 142
- Leather, 141, 432, 443
- Market, 146
- Mineral products concentration at mines as aid to, 141

DECENTRALIZATION OF INDUSTRY—(Continued)

- Paper, 476, 489
- Porcelain, 143
- Potteries, 143
- Power, 143
- Railroads, 144
- Raw materials, 140
- Steel, 192, 205-211
- Substitutes, as aid to, 141
- Transportation, 144
- Trend toward, 140
- Wool, 380, 393
- DIESEL ENGINES, 70
- DISEASES, OCCUPATIONAL, 584
- DISTILLERIES,
 - New England, 94
 - Utensils, 162, 166, 167
- DISTRIBUTION (See "Market," "Peddlers")
- DYEING, 367

E

EARTH, INTERNAL HEAT AS POWER SOURCE, 81

EIGHT HOUR DAY, STEEL INDUSTRY, 203

ELECTRIC FURNACES, 191

ELECTRIC POWER, 71-80

- Automobiles, 215, 239
- Capital investment, 79
- Carbo-electric plants, 76
- Cement industry, 508
- Central stations, 73-80
- Cotton mills, 314, 349
- Derivation, as by-product from ovens and furnaces, 191
- Discovery, 71
- Dynamos, operated by gas engines, 191
- Hydro-electric plants, 76
- Individual production, 72
- Lighting by, 71-73
- Production, 80
- Rented, 75, 316
- Steel manufacturing by, 190
- Street railways, run by, 73
- "Super power," 77-80
- Uses, 71

EMPLOYEE STOCK OWNERSHIP, 300, 344, 587

EMPLOYEES (See "Labor")

EMPLOYMENT OFFICES, 571

ENGINES, Boilers, "flash," 215

- Diesel, 70
- Gas, 68-71
- Internal Combustion, 68-71
- Steam, 63

ERIE CANAL, CEMENT CONSTRUCTION, 497

EXPERIMENT STATIONS, AGRICULTURAL, 24

EXTRACTIVE INDUSTRIES, (See also "Agriculture," "Fishing," "Lumbering," "Mining")

Colonial period, importance, 100

F

FACTORY SYSTEM, 100-119 (See also "Craftsmanship," "Household Manufacture")

- FACTORY SYSTEM—(Continued)
 Advertising in relation to, 115
 British Colonial policy, 103
 Buying power as affecting, 113
 Capital investment, 101, 110, 115
 Colonial period, 100-104
 Corporate form of organization, 115
 Craftsmanship vs., 98
 Credit system as affecting, 116
 Evolution, 83, 86, 95, 97, 106
 Extractive industries as affecting, 100
 Financial situation,
 Colonial period, 102
 Post Revolutionary period, 110
 Germ, 366
 Household manufacturing vs., 98
 Labor,
 Colonial period, 95, 101
 Post Civil War Period, 570-592 (For
 detailed index see "Labor")
 Post Revolutionary, 109
 Status, 570
 Machinery, post Revolutionary, 109
 Management, 118
 Markets,
 Colonial period, 100, 103
 Post Civil War, 113
 Modern, 119
 New England post Revolutionary period,
 107
 Post Civil War period, 112-119
 Post Revolutionary period, 104-112
 Railroad's influence on,
 Post Civil War period, 113
 Post Revolutionary, 108
 Raw materials,
 Colonial, 106
 Post Civil War, 112
 Revolutionary War, effect on, 104
 Sewing machine, 109
 Steam power, 109
 Tariff protection, 117
 War, as affecting, 86, 106
 Water power, 107
 FAIRS, CATTLE, 255
 FARMING (See "Agriculture")
 FEDERAL LAND POLICY, 25
 FEDERAL RESERVE SYSTEM, ESTABLISHMENT,
 116
 FELLOW SERVANT DOCTRINE, 584
 FELT, 366, 441
 FINANCE,
 Factory as affected by,
 Colonial period, 102
 Post Civil War period, 115
 Post Revolutionary period, 110
 FIREARMS, 91, 122, 169, 173
 FIRESIDE OCCUPATIONS (See "Household
 Manufacture")
 FISHING,
 Iron industry as affected by, 167
 Meat industry as affected by, 247
 New England, effect on manufacturing, 93
 FLANNEL, 382, 384
 FLAX, 11, 88, 362
 FLOUR, LOCALIZATION OF INDUSTRY, 96, 121
 FLYWHEEL,
 Invention of, 58
 FOOD MANUFACTURING, (See also "Canneries," "Meat")
 Household manufacture, 89, 98
 New England, 93
 FORD CARS, DECENTRALIZATION OF MANUFACTURE, 147
 FOREST RESERVES, 36
 FORESTRY (See "Lumbering")
 FORGES (See "Iron Forges")
 FOUNDRIES, 162, 172, 175, 192
 FUEL (See also "Charcoal," "Coal,"
 "Coke," "Gas," "Wood")
 Blast furnace gas, 190
 Boilers, steam, 66
 Decentralization of industry as affected
 by, 143
 Furnaces,
 Glass, 532
 Iron, 162, 164, 167, 170, 176, 177, 181
 183, 185
 Kilns, 507, 520
 Natural resources vs. water power, 77
 FULLING MILLS, 91, 369
 FURNACES, (See also "Fuel," "Kilns")
 Electric, 191
 Glass, 531
 Hot blast, 179
 Iron making, 178, 179, 181, 182, 191
 Open hearth, scrap from, 193
 Puddling, 178
 Water-power applied to, 178
 FURNITURE,
 Decentralization, 142
 Localization of industry, 122
 Wood substitutes, 142
- G**
- GAS, BLAST FURNACE, 190
 GAS ENGINE (See "Internal Combustion
 Engine")
 GLASS, 527-546
 Annealing, 531
 Beads, 529
 Bottles, 529
 Machinery, 537-540
 Capital investment, 534
 Chemical ware, 544
 Colonial period, 527, 529
 Continuous tank, 534
 "Crown glass," 541
 Decentralization of industry, 143
 Electric lighting equipment, 542
 Fuel, 532
 Furnaces, 531
 Gauges, 544
 Handicraft stage, 530
 Labor, 527, 532, 536, 538, 542
 Shop system, 536
 Leer, 531
 Localization of industry, 123
 Machinery, 527, 536-543

GLASS—(Continued)

- Mirrors, 528
- Optical, 544
- Origin, 527
- Petroleum as affecting, 533
- Plate, 531
- Pressed, 530
- Raw material, 531
- Scale of production, 545
- Specialization, 545
- Status of industry, 543
- Table ware, 529
 - Machinery, 542
- Tubing, 543
- Venetian, 528
- Wages, 535
- Window glass, 529
 - Machinery, 540
- GLUE, 131, 257, 274
- GOATSKIN, 435, 444
- GOLD MINING, 46, 50, 111
- GOLD STANDARD, ADOPTION, 116
- GRAIN, MACHINERY, 21
- "GREENBACKS," ISSUE OF, 116
- GRIST MILLS, 91
- GUILDS, 548
- GUNS, 169, 173
- GUNSMITHS, 91

H

- HANDICRAFTS (See "Craftsmanship")
- HARD TIMES, LOCALIZED INDUSTRY, DIS-
ADVANTAGE IN, 139
- HARDWARE,
 - Builder's, sale by peddlers, 155
 - Localization of industry, 125
- HAT-MAKING, 104
- HAY, 7
- HEMP, 7, 11
- HIDES, (See also "Leather")
 - Exports, 429
 - Imports, 432, 439
 - Quality, decline in, 438
 - Scarcity, 437
 - Sources, 427, 430, 431, 433
- HOGS, (See also "Meat Pork Packing")
 - Cattle vs., 252, 265
 - Frontier, 15
 - Prices, effect of railroads on, 263
 - Production, expansion due to railroads,
264
- HOME INDUSTRIES (See "Household Manu-
facture")
- HOMESTEAD-ACT, 25, 557
- HORSEPOWER, DEFINITION, 64
- HORSES, 9, 22, 59, 254
- HORSESHOES, 178
- HOSIERY, 95, 156, 346, 370, 385, 412
- HOURS OF LABOR,
 - Cotton mills, 325, 356
 - Reduction, 580
 - Steel industry, 203
- HOUSE-WRECKING, STEEL SCRAP FROM, 193

- HOUSEHOLD MANUFACTURE, 83-90, (See also
"Craftsmanship," "Factory System")
- British Colonial policy, effect on, 84
- Cotton, 289, 294, 329, 330, 336, 338, 389
- Craftsmen's shops
 - Supplementing, 90, 370
- Factory system vs., 98
- Itinerant craftsmen, supplementing, 90,
549
- Labor, 85, 88, 547, 548, 551
- Leather, 87, 429
- Market, 87
- Pioneer, 84
- Products, 88
- Raw materials, 87
- Shoes, 446
- Silk, 413
- Survivals, 83, 87, 97
- Village mills supplementing, 90
- Wars, effect on, 86, 371
- Wool cloth, 87, 368, 371
- HYDROELECTRIC POWER PLANTS, 76

I

- IMMIGRATION,
 - Federal land policy as affecting, 25
 - Labor's attitude, 574
 - Quota laws, 576
- IMPULSE WHEEL, 62
- INCLINED PLANE AND ROLLERS, IN-
VENTION OF, 58
- INDIANS, AGRICULTURE AS INFLUENCED BY,
6
- INDIGO, 12, 85, 330
- INDUSTRIAL ACCIDENTS, 584
- INDUSTRIAL FAMILIES, LOCALIZATION OF IN-
DUSTRIES, 128
- INDUSTRIAL WORKERS OF THE WORLD, 565
- INDUSTRIES (See "Decentralization of In-
dustry," "Localization of Industry,"
also under names of industries)
- INTEREST RATES, COLONIAL PERIOD, 101
- INTERNAL COMBUSTION ENGINES, 68-71
 - Automobile, 215
 - Agricultural machinery, 22
 - Blast furnace gas as fuel, 191
 - Cotton mills, 317
 - Invention, 215
- INVESTMENT (See "Capital Investment")
- IRON, 162-185 (See also "Steel")
 - Blacksmiths, 91
 - Casting, separation from smelting, 172,
177
 - Cincinnati rolling mills, 175
 - Colonial manufacture, 104, 163-173
 - Commerce in relation to, 166
 - Discovery, 163
 - Equipment for making, colonial period, 164
(See also under this head "Forges,"
"Foundries," "Furnaces," "Rolling
Mills")
 - Export, prohibited, 164
 - Fabrication, prohibited, 173

IRON—(Continued)

- Family control of factories, 127
- Forges,
 - Early local, 163
 - "High-water forges," 165
 - Methods, 178
 - Survival, 165
- Foundries, 163, 172, 175
- Fuel for making,
 - Charcoal, 162, 164, 167, 170, 177, 181
 - Coal, 181
 - Coke, 176, 183, 185
- Furnaces,
 - Anthracite, 181
 - Capacity, 182
 - Electric, 191
 - Hot blast, 179
 - Puddling furnace, 178
 - Water power applied to, 178
- Great Valley, 173
- Hanging Rock, 174
- Ironton, 174
- Juanita Valley, 171, 176
- Lancaster, 171
- Lime for making, supply 164, 167
- Localization of industry, 162, 164, 165
- Market outlet,
 - As determining factor of location, 162, 167
 - Automobiles, 163
 - Colonial period, 162
 - Commerce, 166
 - Cooperage, 167
 - Distilling, 162
 - Eastern industrial expansion, 162, 177
 - Fishing, 167
 - Massachusetts, 166
 - Middle west agricultural expansion, 162, 174
 - Railroads, 162
 - Shipbuilding, 162, 166
 - Water works, 163, 178
 - Western, 162, 168
- Mining, 45, 46, 50
- Monongahela, 176
- New England manufacture, 93, 166, 167
- Ore,
 - Bog ore, 168
 - Lake Superior, 184, 185
 - Supply, 164, 168, 170, 174, 176
- Pittsburgh, rolling mills, 176, 185
- Post Revolutionary manufacture, 46, 108
- Process, technical improvements, 162, 178
- Production, record, 203
- Products,
 - Anchors, 166
 - Armament, 166
 - Axes, 169
 - Bands for barrels, 167, 258
 - Cincinnati, 175
 - Colonial, 163, 164, 166
 - Effect of market on, 162
 - Frontier demand, 169
 - Guns, 169, 173
 - Horseshoes, 178

IRON—(Continued)

- Products—(Continued)
 - Nails, 88, 162, 164, 166
 - Pittsburgh, 176
 - Pots and kettles, 163, 166, 167, 169, 170
 - Rails, 180
 - Tools, 163, 169, 173
 - Wire, 177
- Raw materials, supply, 162, 164, 170
 - (See also under this heading "Fuel," "Lime," "Ore")
- Rolling mills, 172, 174, 175, 176, 185
 - Grooved roll, 178
- Salisbury, manufacturing at, 170
- Smelting,
 - Effect of fuel on localization, 162
 - Separation from rolling, 172, 175
- Stainless, 194
- Steel differentiated from, 186
- Water transportation, importance, 171, 176

J

JEWELRY,

- Localization of industry, 122
- Sale by peddlers, 155

K

- KANGAROO SKIN, 435
- KILNS, (See also "Furnaces")
 - Brick, 520
 - Cement, 504, 507
 - Pottery, 525
 - Rotary, 504
- KITCHEN UTENSILS, STEEL, 194
- KNIT GOODS, 95, 346, 370, 385
 - Localization of industry, 122, 126

L

- LABOR, 547-569 (See also "Women in Industry")
 - Agrarianism, 556
 - Agriculture, 8, 9, 11, 14, 22
 - American Federation of Labor, 554, 563
 - Animosity to "Wall Street," basis, 111
 - Arbitration of disputes, 590
 - Balanced male and female employment, 122
 - Brick, 520
 - Child,
 - Colonial period, 548
 - Cotton manufacture, 303, 305
 - Opposition to, 576
 - Closed shop, 583
 - Colonial period, 547-551
 - Communitistic experiments, 557
 - Convict, 95, 101, 580
 - Cooperative community, 548
 - Cooperative enterprises, 559
 - Cotton growing, 333, 339
 - Cotton mills,
 - British, 306
 - Northern, 302, 305, 306, 324, 357
 - Southern, 335, 342, 344, 351-356

LABOR—(Continued)

- Craftsmen, 95, 549, 551
 - Itinerant, 549
- Decentralization of industry as affecting, 147
- Disputes, agencies for settlement, 590
- Economic pressure by, (See below under "Unions")
- Employee stock ownership, 587
- Employment, securing, 570
- Factory,
 - Colonial period, 95, 101
 - Post Revolutionary period, 109
- Free land movement, 556
- Glass making, 527, 532, 536, 538, 542
- Guilds, 548
- Hazardous occupations, 577
- Home work,
 - Advantages in concentrated industry, 133
 - Shoes, 448
- Hours, 203, 325, 356, 580
- Household manufacturing, 85, 88, 547, 548, 551
- Immigration, as affecting, 574, 576
- Indentured servants, 549
- Industrial accidents, 584
- Industrial Workers of the World, 565
- Knights of Labor, 562
- Localization of industry,
 - Advantages to, 131, 136
 - Disadvantages to, 139
- Market, disorganization, 571
- Meat industry, 266
- Mobility, 133
- Negro, 339, 352, 576
- Occupational diseases, 584
- Old age pensions, 586
- Paper, 475
- Political parties,
 - American, 553, 555
 - British 553, 555
- Political reform, program, 553-556
- Post Civil War period, 561-569, 570-592
- Post Revolutionary period, 551-561
- Potteries, 525
- Problems, 570-592
- Productivity, post Civil War period, 113
- Profit sharing, 588
- Railroad, unions, 563
- Railroads, as affecting, post Revolutionary, 109
- Restriction of output, 583
- Share in proceeds of output, 547
- Shoe industry, 448, 464
- Shop councils, 589
- Silk, 421
- Skilled,
 - Advantages in concentrated industries, 131
 - Decentralization of industry as affecting, 142
- Slave, Colonial period, 550
- Social reform program, 556-560

LABOR—(Continued)

- Socialist Party, 556
 - Status,
 - Early, 570
 - Factory system, 547, 570
 - Strikes, beginning, 552, 560
 - Subdivision of work, 448, 552
 - Supply localization of industry due to, 123
 - Trade agreements, 590
 - Unemployment, 572
 - Unions, 560-569
 - Beginning, 552, 560
 - British, 555
 - Civil War as affecting, 561
 - Conspiracy cases, 552, 560
 - Evaluation, 567
 - Localized industry at disadvantage from, 137
 - National, 561
 - Organizations, 561-566
 - Weapons, 533 (See also "Boycotts," "Strikes")
 - Weapons, 560
 - Wool industry, post Revolutionary, 381
 - Workmen's compensation laws, 585
- LAND,
- Federal land policy, 25
 - Free land movement, 556
- LARD, 257
- LEAD MINING, 45, 50
- LEATHER, 427-444 (See also "Shoes")
- American Hide and Leather Company, 443
 - Chamois, 428
 - Chrome, 436
 - Colonial, 429
 - Combines, 442
 - Craftsmen's shops, 91, 94
 - Curriery, 429
 - Decentralization of industry, 141, 432, 443
 - Demand, 439
 - Economics, 440
 - Export, 429
 - French glove, 428
 - French kid, 435
 - Hides,
 - Decline in quality, 438
 - Exports, 429
 - Imports, 432, 439
 - Scarcity, 437
 - Sources of supply, 427, 430, 431, 433
 - Household manufacture, 87, 88, 429
 - Imports, 435
 - Kangaroo, 435
 - Localization of industry, 139, 433
 - Market, 432
 - Morocco, 428, 435
 - Packers' Tanneries, 433, 438
 - Patent, 436
 - Post Civil War period, 433-444
 - Post Revolutionary period, 431
 - Preservatives, 427
 - Price, 430, 438
 - Raw materials (See under this heading, "Hides," "Skins," "Tanning Agents")

LEATHER—(Continued)

- Regional specialization, 430
 - Scale of operations, 440, 442
 - Scrap, 439
 - Skins,
 - Goat, 435, 441
 - Kangaroo, 435
 - Sources of supply, 427, 430, 432, 433
 - Sole, 436, 438
 - Substitutes, 439, 441
 - Tanning, 428, 430, 433
 - Tanning agents,
 - Chrome, 436
 - Export, 431
 - Import, 434
 - Quebracho tree, 434
 - Scarcity, 437
 - Sources, 427, 428
 - Tan bark mills, 430
 - Tannin extract, 433
 - Tawing, 428, 435
 - United States Leather Co., 442
 - Upper leathers, 434, 441
 - "Vici" kid, 436
- LEVER, INVENTION OF, 58
- LIGHTING, ELECTRIC, 71-73
- LIME, USE IN IRON MAKING, 164, 167
- LIVESTOCK, (See also "Cattle," "Hogs," "Horses," "Poultry")
- Breed, improvement, 285
 - Driving, beginning of, 248
 - Export, Colonial New England, 247
 - Fairs, Colonial period, 249
 - Markets,
 - Colonial period, 248-251
 - Geographical decentralization, 267
 - Market places, 249
 - New England, 7, 9, 10, 15
 - Production,
 - Colonial period, 247
 - Decline, 284
 - Shows, 23
 - Western, 17, 253
 - Whiskey Rebellion, effect on, 253
 - Variability, 275
- LOCALIZATION OF INDUSTRY, 120-140
- Accessories, manufacture as cause of, growth, 129
 - Advantages, 131-136
 - Balance of, 140
 - Aluminum, 123
 - Automobiles, 125, 128, 129
 - Brass, 125, 127, 129, 130
 - Brick, 520
 - Buying, advantages, 134
 - Calcium carbide, 123
 - Cap making, 130
 - Capital investment as factor, 128
 - Causes, 120-127
 - Cement, 130, 499, 511
 - Chance, as cause, 126
 - Cigars, 121
 - Coal supply, as cause, 123

LOCALIZATION OF INDUSTRY—(Continued)

- Competition, as disadvantage, 138
- Cotton, 123, 127, 128, 129, 297, 313, 357
- Disadvantages, 136-140
- Division of manufacture, growth due to, 129
- Family control, growth due to, 127
- Firearms, 122
- Flour, 121
- Furniture, 122
- Glass, 123
- Glue, 130
- Growth, 127-131
- Hard times in, 139
- Hardware, 125
- Home work, 133
- Industrial family, growth due to, 128
- Investment of local capital, growth due to, 128
- Iron and steel, 125, 127, 162, 164, 165, 185
- Jewelry, 122
- Knit goods industry, 122, 126
- Labor,
 - Advantages to employee, 131, 136
 - Advantages to employer, 131, 136
 - Disadvantages to employee, 139
 - Home workers, 133
 - Skilled, 131
- Labor supply, as cause, 123
- Labor unions, strength in, 137
- Leather, 433
- Machinery making, 125, 127
- Market,
 - Concentration, advantages, 135
 - Distance from, 136
 - Proximity, as cause, 124
- Meat, 262-287, 433
- Mining, 52
- Monopoly, as cause, 126
- Motion pictures, 125, 129
- Natural gas supply, as cause, 123
- Oil refining, 126
- Paper, 122, 125, 473, 489
- Pottery, 128, 143, 524
- Preserving, 120
- Prestige, growth due to, 131
- Raw materials,
 - Distance from, 137
 - Source of supply as cause, 120
- Rubber, 121
- Shoes, 126, 127, 129, 137, 463
- Soap, 121
- Sugar refining, 126
- Textiles, 125, 130
- Tool making, 125
- Topography, as cause, 125
- Vehicles, 121
- Waste product utilization, growth due to, 130
- Water power, as cause, 122
- Whips, 126
- Wood pulp, 123
- Wool, 123, 370
- Worsted, 393

LOG CABINS, CONSTRUCTION, 163
 LOGGING CAMPS, 39
 LOOMS, (See also "Cotton," "Weaving,"
 "Wool, Weaving")
 Power, invention, 97
 LUMBERING, 28-44 (See also "Wood")
 Central forest, 31
 Colonial period, 28
 Commercial lumberman, 29
 Competition in, 31, 38
 Depletion of forests, 34
 Farm, 7, 29
 Freight rates, 32
 Logging camps, 39
 Markets, 31, 112
 Methods, 30
 Ownership of forests, 36, 37
 Pioneer, 28
 Prices, 34
 Products, 39 (See also "Wood")
 Regional specialization, 30
 Reservations, 36
 Resources, 31
 Transportation, 33

M

MACHINERY,
 Agricultural, 20, 125
 Bottle making, 537-540
 Cement, 506
 Cotton, 125, 289, 291, 301, 306, 317, 349
 Factory as affected by, post Revolutionary
 period, 109
 Immigration as affecting, 576
 Meat industry, 276, 277
 Mining, 55
 Nail making, 166
 Paper, 479-484
 Potteries, 525, 526
 Shoe, 127, 454, 455-462
 Silk, 413, 425
 Standardization and interchangeable parts,
 110
 Steel outlet in, 206
 Steel scrap, 193
 Textile, British colonial policy, 104
 Wool, 290, 373, 381, 391, 394

MANAGEMENT,
 Factory as affected by, post Civil War,
 118
 Family control, growth due to, 127
 First generation, post Civil War, 118

MANUFACTURING, (See "Craftsmanship,"
 "Factory System," "Household Manu-
 facture," also under name of article)
 Agriculture in relation to, 3, 19
 Automobiles as affecting, 244
 Commerce as affecting, 93
 Division of, growth of localization of
 industries due to, 129
 Eastern, effect on iron industry, 162, 177
 Evolution, stages in, 83
 Fishing industry as affecting, 93
 Middle colonies, Colonial policy on, 86

MANUFACTURING—(Continued)
 Mining in relation to, 56
 New England, effect of British colonial
 policy on, 86
 Raw materials, agriculture as source, 3
 Shipbuilding as affecting, 93
 Southern, effect of British colonial policy
 on, 85

MARKET,
 Agricultural products, 3, 19, 112
 Automobiles, 231, 238-242
 Brick, 521
 Cement, 501, 509
 Cotton goods, 318, 346
 Decentralized industry, 146
 Factory as affected by,
 Colonial period, 103
 Post Civil War period, 113
 Fairs, Colonial period, 249
 Foreign, need of, 117, 119
 Fresh meat, western, 272
 Household manufactures, 87
 Iron, 162, 163, 166, 167
 Labor, disorganization, 571
 Leather, 432
 Localization of industry, in relation to,
 124, 135, 136
 Location as affecting decentralization of
 industry, 146
 Lumber, 31
 Manufactures, British colonial policy, 84,
 104
 Market places, 249
 National, division into districts, 146
 Shoes, 450
 Steel, 162, 174, 205, 206, 210
 MASS PRODUCTION,
 Automobile parts, 231, 238
 Cotton goods, 302, 313
 Factors, 114
 Sewing silk, 416
 MEAT, (See also "Cattle," "Hogs,"
 "Leather," "Livestock," "Sheep")

Beef,
 Canned, 265
 Fresh (See below under "Fresh Meat")
 Slaughtering, 245, 262, 265
 Vs. pork, 251
 Beef packing,
 By-products, 257
 Chicago, 262, 265
 Brighton market, 250
 By-products, 257, 274 (See also
 "Leather")
 Capital investment, 286
 Capital turnover, 278
 Centralization of industry, 262-287
 Chicago, 262-287
 Beef packing, 262-265
 Beginning, 261
 By-products, 274
 Export, 283
 Fresh beef trade, 267-274
 Leaders in industry, 262
 Pork packing, 262, 264

MEAT—(Continued)

Chicago—(Continued)

- Rise of industry, 262
- "Trust busting," 279-282
- Civil War, effect on industry, 261
- Colonial period, 245-253
- Consumption, 284
- Decentralization of industry, geographical, 267
- Demand, variability, 277
- Export,
 - Chicago, 283
 - Cincinnati, 258
 - Colonial New England, 247
- Farmer butchers, 245
- Fishing industry as outlet, 247
- Fresh, 267-274
 - Branch houses for western, 270
 - Car routes, 271
 - Eastern and Southern market, 254
 - Local industry, 245, 269
 - Market, 272
 - Peddler cars, 271
 - Preference for beef as, 245
 - Railroads' opposition, 269, 270
- Frozen, 266
- Industry, status, 286
- Inspection, federal, 281, 282
- Jersey City, 277
- Labor, 266
- Leaders in industry, Chicago, 264
- Local butchers—meat dealer—system, 246
- Localization of industry, 245-261
- Machinery used in industry, 276, 277
- Manufacturing problems, 275-278
- Market,
 - Cincinnati products, 258
 - Colonial New England, 247
 - Eastern and southern, 254
 - Fresh beef, 272
- Mutton, 245
- Packing,
 - Chicago (See above under "Chicago")
 - Combined with slaughtering, 263
 - Local industry, 245
 - New England, 93
 - Preeminence of pork, 245, 252
 - Seasonal character, 244, 256
 - Slaughtering separated from, 246, 253, 257
 - Steel outlet in, 205, 206
- Pork vs. beef, 251
- Pork packing,
 - Beginning in West, 255
 - By-products, 257
 - Chicago, 262, 264
 - Cincinnati, 255-258
 - Colonial period, 252
 - Preeminence, 245
- "Porkopolis," 255
- Post Civil War period, 262-287
- Post Revolutionary period, 253-261
- Preserved, first market, 247
- Railroads as affecting, Chicago, 262

MEAT—(Continued)

- Raw materials (See "Cattle," "Hogs," "Livestock," "Sheep")
 - Refrigeration, 268
 - Refrigerator cars, 268
 - Scale of operation, 287
 - Slaughterhouses,
 - Chicago, 262, 265
 - Location near sources of raw materials, 245
 - Municipal control, 250
 - Slaughtering,
 - Combined with packing, 263
 - Geographical decentralization, 267
 - Separated from, packing, 253, 257
 - Stockyards, Chicago, 262
 - "Trust busting," 279
 - Westward migration, effect on industry, 253
- MERGERS,
- Cement, 514
 - Cotton, 319
 - Paper, 492
 - Steel, 197-202
- METAL INDUSTRY, (See also "Aluminum," "Brass," "Iron," "Steel")
- Lancaster, Pa., 95
- MIDDLE STATES,
- Agriculture, 5, 9, 16
 - Manufacturing, British colonial policy on, 86
 - Village industries, 92
- MIDDLE WEST,
- Agriculture, 162, 174
 - Automobile outlet in, 241
 - Shoes, 465
- MILLS,
- Tidal, 61
 - Village, 91
- MINING, 44-57
- By-products, 54
 - Capital, investment 55
 - Clay, 45, 51
 - Coal, 45, 47, 49
 - Colonial period, 44
 - Commerce in relation to, 56
 - Concentration of product at mines, 141
 - Copper, 45, 48, 51
 - Economic characteristics, 51-56
 - Gold, 46, 50
 - Iron, 45, 46, 50
 - Lake Superior, 184
 - Land tenure, 54
 - Lead, 45, 50
 - Localization, 52
 - Machinery, 55
 - Market, 56
 - Natural gas, 49
 - Petroleum, 48
 - Post Civil War, 49-51
 - Post Revolutionary period, 46-49
 - Production, 51
 - Quarrying, 51
 - Scale of operations, 53
 - Silver, 50

MINING—(Continued)

- Steel outlet in, 162, 205
- Steel scrap, 193
- Technological improvements, 50
- Zinc, 50

MINTS,

- Colonial, establishment, 102
- United States, establishment, 111

MIRRORS, 528

MONEY (See "Currency System")

MOROCCO, 428, 435

MOTION PICTURES, LOCALIZATION OF INDUSTRY, 125

MOTOR BUSES, 227

MOTORS, DEVELOPMENT, 215

MUTTON, COLONIAL, 368

N

NAILS, 88, 163, 164, 166

NATIONAL BANK SYSTEM, ESTABLISHMENT, 116

NATIONAL FORESTS, 37

NATURAL GAS,

- Fuel, 49, 68, 534
- Supply, localization of industries due to, 123

NATURAL RESOURCES, (See also "Agriculture," "Fishing," "Lumbering," "Mining")

- Deficiencies in, 112

NAVAL STORES, 85

NEW ENGLAND,

- Agriculture, 5, 6-9, 16
- Commerce, effect on manufacturing, 93
- Cotton manufacture, 107, 288-328 (For detailed index see "Cotton")
- Craftsman's shops producing for sale, 92
- Crops, 6, 8, 17
- Fishing industry, effect on manufacturing, 93
- Labor supply, skilled, 132
- Manufacturing, effect of British colonial policy on, 86
- Paper industry, 489
- Shipbuilding, effect on manufacturing, 93
- Tidal mills, 61
- Water power, resources, 60
- Wool manufacture, 97, 372

NORTHWEST, WATER POWER RESOURCES, 60

O

OCCUPATIONAL DISEASES, 584

OIL,

- Fish, 94
- Fuel, 507
- Refining, localization of industry, 126
- Steel, outlet in, 162, 205
- Steel scrap from industry, 193

OLD AGE PENSIONS, 586

OVENS,

- Coke,
- Beehive, 190, 208
- By-product, 190, 209

OXEN, 7, 15, 59

P

PACKING INDUSTRY (See "Meat")

PANICS, POST REVOLUTIONARY PERIOD, 111

PAPER, 471-494 (See also "Printing")

- American Writing Paper Co., 493
- Book paper, 486, 493
- Boston mills, 473
- British manufacture, 471
- Building, 486
- Capital investment, 478, 487
- Cardboard, 484, 486
- Classification, 485
- Colonial period, 471-476
- Decentralization of industry, 476, 489
- Demand, post Revolutionary period, 483
- Early mills, 472
- "Fine paper," 486
- Hand made, 483
- Holyoke, 490
- Imports, 475
- International Paper Co., 492
- "Ivy" mills, 472
- Labor, 475
 - Skilled, 478
- Localization of industry, 122, 125, 473, 489
- Machinery, 479-484
 - Cylinder, 480
 - Fourdrinier, 482
 - Hollander, 479
 - Jordan, 480
 - Slow adoption, 482
- Mergers, 492
- Methods of making, early, 479
- Monopoly, 472
- New England, 489
- Newsprint, 484, 486
- Origin, 471
- Parchment, 471
- Philadelphia mills, 474
- Post Revolutionary period, 476
- Rags,
 - Imports, 477
 - Shortage, 474, 475, 476, 477, 483
 - Substitutes, 484
- Raw material (See under this heading, "Rags," "Wood Pulp")
- Revolutionary War, effect on, 475
- Rope, 484, 486
- Scale of operations, 488
- Status of industry, 494
- Straw, 484
- Tapa cloth, 471
- Tissue, 486
- Water power mills, 478
- West Virginia Pulp and Paper Co., 493
- Wood pulp, 484-488, 494
 - Imports, 491
- Wrapping paper, 484, 486
- Writing paper, 493

- PAPER CURRENCY,
 Paper for, 473
 Standard national, 116
- PEARLASH, 8
- PEDDLERS, 149-161
 Articles sold by, 152, 155
 Buttons, sale by, 153
 Clocks, sale by, 154
 Colonial maritime, 149
 Decline of system, 158
 Indirect service, 156
 Jewish, 158
 Revival of system, 160
 Selling organization, 151
 Service rendered by, 160
 Tin peddlers, 150
 Wayfarers other than, 157
 Wholesale, 156
 "Yankee peddlers," 150
- PELTON WHEELS, 62
- PETROLEUM,
 Fuel, 48, 68, 534
 Glass making, as affected by, 533
- PLANTATIONS,
 Colonial, 11
 Manufacturing on, 85, 330
- PLOW, DEVELOPMENT, 20
- POLITICAL REFORM, LABOR'S PROGRAM, 553-556
- POPULATION,
 Center of, 124
 Revolutionary War, 101
- PORCELAIN, DECENTRALIZATION OF INDUSTRY, 143
- PORK PACKING (See "Meat")
- POST CIVIL WAR PERIOD,
 Agriculture, 16-20
 Cotton manufacture, south, 338-356
 Factory system, 112-119
 Labor, 561-569, 570-592
 Leather, 433-444
 Meat, 262-287
 Mining, 49-51
 Silk, 417-425
 Wool, 388-404
- POST REVOLUTIONARY PERIOD,
 Agriculture, 13-16
 Cotton manufacture,
 North, 97, 106, 291-298
 South, 336
 Factory system, 104-112
 Labor, 551-561
 Leather, 432
 Mining, 46-49
 Paper, 476
 Silk, 414-417
 Wool, 371-388
- POTASH, 8
 Utensils for making, 169
- POTS AND KETTLES, IRON, 163, 166, 167, 169, 170
- POTTERY, 522-526
 Chinaware, 523
 Classification, 523
 Decentralization of industry, 143
- POTTERY—(Continued)
 Early American kilns, 522
 Earthenware, 523
 Electrical supplies, 523, 525
 Inefficiency in industry, 524
 Kilns, tunnel, 525
 Labor, 525
 Localization of industry, 128, 524
 Machinery, 525, 526
 Origin, 522
 Rookwood, 523
 Sanitary ware, 96, 523, 525
 Scale of operations, 526
 Stoneware, 523
- POULTRY, 9
- POWER, 58-82
 Animal, 7, 15, 58, 59
 Compressed air, 80
 Decentralization of industry, as affected by, 143
 Electric, 71-80 (For detailed index see "Electric Power")
 Gas engine, 68-71
 Internal combustion engine, 68-71
 Internal heat of earth, 81
 Primitive, 58
 Solar heat, 81
 Status of industry, 82
 Steam, 62-68 (For detailed index see "Steam Power")
 Water, 59-63 (For detailed index see "Water Power")
 Waves as source, 81
- PRESERVING INDUSTRIES, LOCALIZATION, 120
- PRESS, Agricultural, 23
- PRESTIGE, LOCALIZATION OF INDUSTRY, 131
- PRINTING, (See also "Paper")
 Development, 483
 Origin, 471
 Press, first American, 473
- PROFIT SHARING, 588
- PROTECTION (See "Tariff")
- PUSHCARTS,
 Peddling from, 160
- Q
- QUALITY PRODUCTION, COTTON, 304, 306, 313
- QUARRYING, 51
- QUEBRACHO BARK, 434
- R
- RAILROADS,
 Agriculture as affected by, post Revolution, 109
 Cattle ranges as affected by, 258
 Decentralization of industry as affected by, 144
 Factory as affected by,
 Post Civil War period, 113
 Post Revolutionary period, 108
 Freight rates,
 Lumber, 32
 Steel, 207

RAILROADS—(Continued)

- Fresh meat traffic, opposition, 269, 270
- Hog production as affected by, 264
- Iron industry, outlet in, 162
- Labor as affected by, post Revolutionary, 109
- Labor unions, 563
- Meat industry as affected by, Chicago, 262, 264
- Paper industry as affected by, 483
- Refrigerator cars, 268, 270
- Steel industry, outlet in, 205
- Steel scrap, 193

RAILS, 180

RAMIE, 362

RAW MATERIALS,

- Automobiles, 243, 244
- Brick, 519
- British colonial policy, 84
- Cotton (See "Cotton")
- Decentralization of industry as affected by, 140
- Distance from, as disadvantage to localized industry, 137
- Glass, 531
- Iron, 162, 164, 170
- Localization of industry as affected by, 243
- Manipulation, effect on decentralization of industries, 141
- Manufacturing (See "Agriculture," "Fishing," "Lumbering," "Mining")
- Meat (See "Livestock")
- Source of Supply, localization of industry due to, 120
- Steel scrap, 192
- Substitutes, effect on decentralization of industries, 141

RAYON, 362, 425

READY-MADE CLOTHING INDUSTRY, NEW ENGLAND, 93

RED CROSS, HOME MANUFACTURING, 87

REFINING,

- New England, 94
- Oil, localization of industry, 126
- Sugar,
 - Iron utensils for, 166
 - Localization, 126

REFRIGERATION,

- Meat, 268

REFRIGERATOR CARS, 268, 270, 397

REVOLUTIONARY WAR (See "Post Revolutionary Period")

RICE, 12, 16, 85, 330

ROADS, CEMENT, 509

ROPE MAKING, 93

RUBBER, LOCALIZATION OF INDUSTRY, 121

RUM,

- Distilling,
 - Iron utensils for, 162, 166, 167
 - New England, 94

S

SABOTAGE, 566

SALT, REFINING, 94, 167

SATINET, 383

SAWMILLS, 40, 91

SAWS, 40

SCIENTIFIC MANAGEMENT, 143

SCRAP,

- Iron, 191, 192, 193
- Steel,
 - Utilization, 191

SERVANTS,

- Indentured, 11, 101, 549

SEWING MACHINE, 97, 109, 415

SHAWLS, 385

SHEEP, (See also "Mutton," "Wool")

- California, 366, 389
- Colonial period, 366, 367
- Expense of maintenance, 368
- Meat, 390, 391, 397, 398
- Merino, 254, 366, 374, 389, 390, 392
- Range, 389, 397
- Slaughtering, 245

SHIP OUTFITTING, 93

SHIPBUILDING,

- Guilds, 549
- Iron industry as affected by, 162, 166
- New England, effect on manufacturing, 93

SHOES, 445-470 (See also "Leather")

- Brockton, 451
- Brogans, 450
- Capital investment, 455, 462
- Colonial period, 445
- Craftsmen,
 - Itinerant, 447
 - Shops, 445
- Cutting, centralized, 449
- Endicott Johnson Corporation, 468
- Household manufacture, 88, 446
- Industry as leather market, 432
- International Shoe Company, 467
- Labor,
 - Home work, 448
 - Strength of unions, 464
 - Subdivision of labor, 448
 - Women, 448

Leather,

- Economies, 440
- Substitutes, 440, 441
- Localization of industry, 126, 127, 129, 137, 463
- Lynn, 94, 95, 447-451
- Machinery, 454, 455-462
 - Casting, 457
 - Cutting, 459
 - Leasing system, 459-462
 - "Pulling over," 459
 - Sewing, 456
 - Welting, 458
- Manufacture outside New England, 453
- Market, 450
- Men's, 452
- Mergers, 467
- Middle West, 465
- New England, 94, 95, 447-453, 466
- Occupational diseases of makers, 447
- Raw materials, (See also "Leather")

Lynn, 94, 95, 447-451

Machinery, 454, 455-462

- Casting, 457
- Cutting, 459
- Leasing system, 459-462
- "Pulling over," 459
- Sewing, 456
- Welting, 458

Manufacture outside New England, 453

Market, 450

Men's, 452

Mergers, 467

Middle West, 465

New England, 94, 95, 447-453, 466

Occupational diseases of makers, 447

Raw materials, (See also "Leather")

New England supply, 449

SHOES—(Continued)

- Rubber heels, 440
- Scale of operations, 454, 460, 462, 466
- Shoemakers' guilds, 549
- Sole, leather, 434
- Specialization, 450, 451, 463
- Standardization, 454
- Status of industry, 469
- Style factor, 469
- United Shoe Machinery Co., 461
- Uppers,
 - Home work on, 448
 - Leather, 434
- Women's, 451
- SHOP COUNCILS, 589
- SHOPS, CRAFTSMEN'S (See "Craftsmanship")
- SHOWS, LIVESTOCK, 23
- SILK, 405-426
 - Broad silk, 416, 418, 422
 - Byzantium, 406
 - Household manufacture, 413
 - Italy, 407
 - Labor, 421
 - Machinery,
 - Hand looms, 413
 - Power, 425
 - Origin, 405
 - Paterson, 419
 - Pennsylvania, 421
 - Post Civil War, 417-425
 - Post Revolutionary period, 414-417
- Raw,
 - Bounties, 7, 11
 - Colonial period, 408
 - Domestic production, 411
 - Post Civil War supply, 417
 - Post Revolutionary, 409
 - Preparation, 413
- Ribbon, 418
- Rome, 406
- Scale of operations, 424
- Sewing silk and machine twist, 415
- Silk Association of America, 424
- "Spun silk," 413, 422
- Status of industry, 425
- Style factor, 420
- Substitutes, rayon, 362, 425
- Tariff, 418
- Technical efficiency, 425
- Throwing mills, 413, 421
- Weaving, 413, 416
- Weighting, 423
- SILVER,
 - Mining, 50
 - Plated ware, sale by peddlers, 155
 - Whitesmiths, 91
- SKINS, (See also "Leather")
 - Goat, 435, 441
 - Kangaroo, 435
 - Sources of supply, 427, 430, 432, 433
- SLAVE LABOR,
 - Colonial, 9, 11, 101, 330, 550
 - Cotton gin, as affecting, 551
 - Slave traffic, abolition, 551
 - Southern, cotton, 333, 353, 551

SOAP,

- As by-product of packing, 257, 274
- Household manufacture, 89
- Localization of industry, 121
- SOCIAL REFORM, LABOR'S PROGRAM, 556-560
- SOCIALIST PARTY, 556
- SOLAR HEAT, AS POWER SOURCE, 81
- SOUTH, THE,
 - Agriculture, 5, 10-13, 16, 85
 - Cattle raising, 12, 330
 - Cotton growing, introduction, 289
 - Cotton manufacture, 329-364 (For detailed index see "Cotton")
 - Crops, 10-13, 16, 17, 335
 - Gold mining, 46
 - Manufacturing, British colonial policy on, 85
- SOUTHWEST, COTTON MANUFACTURE, 360
- SPECULATION, POST REVOLUTIONARY, 111
- SPINNING, (See also "Cotton," "Silk," "Wool")
 - Vocational education, 95
- STANDARD OF LIVING, POST CIVIL WAR, 114
- STANDARDIZATION,
 - Automobile parts, 231, 232, 237
 - Cotton goods, 302
 - Factories as affected by, 114
- Shoes, 454
- Wool goods, 380
- STATE FORESTS, 37
- STEAM POWER, 62-68 (See also "Engines")
 - Agricultural machinery, 21
 - Automobiles, 214
 - Cotton mills, 290, 309-314, 345, 349
 - Factories, 109
 - Fuel, 66, 190
 - History, 65
 - Sawmills, 40
 - Steam engines, 63
 - Steam turbine, 64
 - Water power, vs., 62, 310
- STEAM TURBINES, 64
- STEEL, 186-212 (See also "Iron")
 - Agriculture as outlet, 162, 174, 205, 206
 - Alloy, electric furnace for, 192
 - Automobiles as outlet, 163, 205
 - Bessemer, 187
 - Bethlehem Steel Company, 199
 - Building as outlet, 162, 205
 - By-product coke,
 - As decentralizing agency, 208
 - Ovens, 190
 - Capital investment, 195
 - Cartels, 200
 - Chromium, 194
 - Competition, 196
 - Construction as outlet, 162
 - Converters, tilting, 188
 - Crucible, inroads of electric furnace in, 192
 - Decentralization of industry, 192, 205-211
 - Early, expense of production, 186
 - Electric, 190
 - Exports, 211
 - Foreign cartels, 200

STEEL—(Continued)

- Foreign combinations, 200
 - Freight rates,
 - As decentralizing agency, 208
 - Effect on market boundaries, 207
 - "Pittsburgh plus," 207
 - Hours of labor, 203
 - Individualization of industry, 194
 - Industry, status, 212
 - Integration of industry, 195
 - International Steel Rail Association, 200
 - Invention, 186
 - Iron differentiated from, 186
 - Kelly patents, 187
 - Localization of industry, 125
 - Machinery as outlet, 206
 - Market, 162, 174, 205, 206, 210
 - Export, 211
 - Mergers, 196-202
 - Mines, as outlet, 162, 205
 - North American Steel Corporation, 199
 - Oil industry as outlet, 162, 205
 - Open-hearth, 189
 - Packing industry as outlet, 205, 206
 - Products,
 - Chromium steel, 194
 - Cost, 186
 - Cutlery, 186, 194
 - Effect of world war on, 202
 - Railroads as outlet, 205
 - Raw materials, scrap, 192
 - Scrap,
 - Sources, 193
 - Utilization, 191, 192, 193
 - Stainless, 193
 - Strikes, Homestead, 203
 - United States Steel Corporation, 196
 - World war effect on, Mergers, 197-202
 - Production, 202
 - Youngstown Sheet and Tube Company, 199
- STOCKINGS, 95, 156, 346, 370, 385, 412
- STORES, COOPERATIVE, 559
- STREET RAILWAYS, ELECTRIC, 73
- STRIKES,
 - Beginning, 552, 560
 - General strikes, 566
 - Homestead Steel strike, 203
 - Issues, 533
 - Successful, proportion, 533
- SUGAR,
 - Maple, utensils, 170
 - Refining,
 - Iron utensils for, 166
 - Localization, 126
 - New England, 94
- SUPER POWER ELECTRIC STATIONS, 77-80
- SURGICAL INSTRUMENTS, 194
- SUSPENDERS, SALE BY PEDDLERS, 155

T

- TANNING (See "Leather")
- TARIFF,
 - British colonial policy, 84

TARIFF—(Continued)

- Factory as affected by, post Civil War period, 117
 - Silk, 418
 - Wool, 378, 392, 394
- TAXES, IMPORT AND EXPORT, BRITISH COLONIAL POLICY, 84
- TAXICABS, 224
- TEXAS, CATTLE INDUSTRY, 259
- TEXTILES (See also "Cotton," "Silk," "Rayon," "Wool")
 - Household manufacture, 89
 - Iron industry as affected by, 177
 - Localization of industry, 125, 130
 - Machinery, British colonial policy, 104
 - Waste utilization, 131
 - Women in, 578
- TIDAL MILLS, 61
- TIMBER (See "Lumbering")
- TIMOTHY, 7
- "TIN" CANS, AS SCRAP, 193
- TINWARE, 150, 151
- TOBACCO, 8, 10, 11, 16, 17, 85, 330
 - Cigar industry, localization, 121
- TOOLS,
 - Agricultural,
 - Early, 20
 - Household manufacture, 88
 - Edged, 125, 173
 - Iron, 163, 169, 173
 - Localization of industry, 125
 - Primitive, 58
- TOPOGRAPHY, LOCALIZATION OF INDUSTRY DUE TO, 125
- TRACTORS, 229
- TRANSPORTATION, (See also "Railroads," "Water Transportation")
 - Decentralization of industry as affected by, 144
 - Land, development, 213
 - Lumber, 33
 - Refrigeration as applied to, 268
- TREADMILL, INVENTION OF, 58
- TRUCK AND FRUIT CROPS, 17
- TRUCKS, MOTOR, 226
- TURBINES, STEAM, 64
 - Water, 61

U

- UNEMPLOYMENT, 572
- UNIONS, 560-569
 - Amalgamated Clothing Workers, 564
 - Beginning, 552, 560
 - Boycotts, 533
 - Bricklayers, 523
 - British, 555
 - Closed shop, 583
 - Conspiracy cases, 552, 560
 - Civil War as affecting, 561
 - Employment offices, 571
 - Evaluation, 567
 - Extent, 568
 - Knights of Labor, 562
 - National, 561

UNIONS—(Continued)

- Organizations, 561-566
- Strikes, issues, 533
- Weapons, 533
- Women in, 577, 579
- UNITED STATES BANKS, ESTABLISHMENT, 110
- UNITED STATES TREASURY, ESTABLISHMENT, 111
- UTENSILS, (See "Pots and Kettles")

V

- VEHICLE INDUSTRY, WOODEN, LOCALIZATION, 121
- VILLAGE INDUSTRIES, (See also "Craftsmanship")
 - Characteristics, 92
 - Household industries, supplemented by, 90
 - Producing for sale, 92
- VOCATIONAL EDUCATION, SPINNING, 95

W

- WAGES,
 - Colonial period, 101
 - Cotton mills, 304, 324, 345, 354
 - Glass making, 535
 - Reduction, post Revolutionary period, 551
 - Women, 579
 - Wool factories, 382
- "WALL STREET," LABOR ANIMOSITY TOWARD, 111
- WARS, HOUSEHOLD MANUFACTURING AFFECTED BY, 86
- WASTE UTILIZATION,
 - Brass, 131
 - Cotton, 477
 - Glue, 131, 257, 274
 - Iron, 130
 - Localization of industries due to, 130
 - Textiles, 131
 - Wool cloth, 130
- WATER POWER, 59-63
 - Cotton mills, 288-308, 332, 336, 338, 349
 - Factories, 107
 - Fulling mill, 369
 - Impulse wheel, 62
 - Localization of industry due to, 122
 - Natural resources vs. fuel resources, 77
 - New England, 60
 - Northwest, resources, 60
 - Paper mills, 478
 - Primitive, 58
 - Silk mills, 420
 - Steam power, vs., 62, 310
 - Tidal mills, 61
 - Water turbines, 61
 - Water wheels, 60-62
 - Wool factories, 372, 375
- WATER TRANSPORTATION, IRON, 171, 176
- WATER TURBINES, 61
- WATER WHEEL, 59, 60-62
 - Impulse wheel, 62
 - Pelton wheels, 62

WATER WHEEL—(Continued)

- Tidal mills, 61
- Water turbines, 61
- Wry wheel, 61
- WATER WORKS, IRON INDUSTRY AFFECTED BY, 163, 178
- WAVES, AS POWER SOURCE, 81
- WEAVING, (See also "Cotton," "Silk," "Wool")
 - American power loom, invention, 97
 - Lancaster, Pa., 96
- WEST,
 - Agriculture, 13-16
 - Cotton growing, 361
 - Free land movement, 557
- WHEAT, 6, 10, 13, 17
- WHIPS, 126
- WHITESMITHS, 91
- WIND POWER, 58
- WINDLASS, INVENTION OF, 58
- WIRE, IRON, 177
- WOMEN IN INDUSTRY,
 - Cotton, 302, 305, 307, 326, 353
 - Immigration as affecting, 576
 - Marriage in relation to, 579
 - Opposition to, 577-580
 - Post Revolutionary period, 107
 - Shoes, 448
 - Silk, 421
 - Wages, 579
 - Worsted mills, 394
- WOOD, 42-44
 - Consumption, 35
 - Craftsmanship, 43
 - Craftsmen's shops, 91
 - Fuel, 67, 533
 - Hard woods, sources, 31
 - Household manufacture, 88
 - Machinery wood working, 43
 - Production, 35
 - Products, 42
 - Raw materials (See "Lumbering")
 - Sawmills, 40
 - Soft woods, sources, 30
 - Substitutes, 44
- WOOD PULP, 484-488, 491, 494
 - Decentralization of industry as affected by, 142
 - Localization of industry, 123
- WOOL, 365-404
 - American Woolen Co., 403
 - Blankets, 382
 - British colonial policy, 368
 - British industry, 367
 - Capital investment, 392
 - Carded, 91, 390
 - Carpets, 366, 386
 - Cashmere, 384
 - Cassimere, 383
 - Colonial period, 367-371
 - Combed, 390, 392
 - Combines, 400
 - Decentralization of industry, 380
 - Demand, 402
 - Dyeing, 367

WOOL—(*Continued*)

- Factories, inspection, 376
- Flannels, 382, 384
- Fulling, 91, 369
- Household manufacturing, 87, 368
- Humphreysville, Manufacturing Co., 375
- Imports,
 - Colonial, 370
 - Post Revolutionary period, 377
- "In the grease," 379
- Labor,
 - Post Revolutionary period, 381
 - Subdivision of functions, 381, 393
- Localization of industry, 123, 370
- Machinery,
 - Adjustable, 381
 - British Colonial policy, 373
 - Combing, 391
 - Early, 290
 - Jacquard loom, 394
 - Knitting frame, 386
- Manufacture, ancient, 366
- Men's wear, 383
- Merino, 374
- Mungo, 398
- Muslim delaine, 391
- National Association of Wool Manufacturers, 400
- New England, post Revolutionary factories, 372
- Origin, 365
- Post Civil War period, 388-404
- Post Revolutionary period, 97, 108, 371-388
- Products, 382-388
- Promotion societies, post Revolutionary, 371
- Rags, collection, 399

WOOL—(*Continued*)

- Raw material,
 - Characteristics, 379
 - Long staple, 390
 - Post Civil War, 388
 - Post Revolutionary, 378
 - Short staple, 390
 - Sources, 3, 397
 - Satinet, 383
 - Scale of operations, 380
 - Shawls, 385
 - Shoddy, 398
 - Spinning, early, 366
 - Status of industry, 401-404
 - Stockings, 95, 346, 370, 385
 - Tariff, 378, 392, 394
 - Wages, 382
 - War as affecting, 377
 - Washed, 379
 - Water power factories, 372, 375
 - Weaving,
 - Drop box, 290
 - Early, 366
 - Flying shuttle, 290
 - Itinerant weavers, 370
 - Jacquard loom, 394
 - Women operatives, 394
 - Women's wear, 384
 - Wool sorters, 379, 381
 - Worsted, 390-394
 - Yarn, 386
- WORKMEN'S COMPENSATION LAWS, 585
- WORSTED, 390-394
- WRY WHEEL, INVENTION, 61

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